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THE FORESTER

THE FORESTER

OR

A PRACTICAL TREATISE
ON THE PLANTING, REARING, AND GENERAL MANAGEMENT OF FOREST-TREES

BY

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ASSISTED BY HIS SON, GEORGE E. BROWN
FORESTER, CUMLODEN, NEWTON-STEWART

FIFTH EDITION — ENLARGED AND IMPROVED

WILLIAM BLACKWOOD AND SONS
EDINBURGH AND LONDON
MDCCCLXXXII

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PREFACE.

THAT a Fifth Edition of 'The Forester' is now called for, is a proof that the work is being appreciated by those who take an interest in Arboriculture.

In preparing the present edition, the greater part of the book has been rewritten, and much additional matter introduced upon important subjects in order to bring it up to the present advanced state of tree-culture.

As forestry is now making rapid progress in all the British Colonies, in India, and in the United States of America as well, the different modes of tree-culture at present put in practice in those parts of the world have received a full share of attention in drawing up this edition. This is necessary in a work of this kind, as the British forester ought to know what is being done in other parts of the world in respect to his profession. Indeed we are of opinion that, in some of our colonies, forestry will ere long be found conducted on as sound principles as obtains in any part of Europe at the present day.

The cost of young trees, wire-fencing, stone-walls, wooden palings, and other works in connection with forestry, have not been stated in the present edition, as no reliable information as to the cost of these can be given suitable to all times and to all parts of the country. The prices of young trees can always be had from public nurserymen, those of wire-fences from merchants who deal in the material, while those of stone-walls, palings, &c. &c., can always be had by taking in offers for performing such works from men who make them their business in the respective neighbourhoods where the works are to be performed.

The Author has here to acknowledge the valuable assistance he has received from his son, George E. Brown, in preparing the present edition of 'The Forester,'—a considerable portion of it having been rewritten and improved by him.

The specific characters of the newer Coniferæ, as given in this work, are taken chiefly from GORDON'S 'PINETUM;' and in writing the section descriptive of the insects injurious to our forest trees, the Author has quoted freely from Miss E. A. Ormerod's excellent work on the subject.

India being an important part of the British empire, the Author is of opinion that a statement showing the present condition of forests in that great country would be acceptable to his readers. In order to obtain a reliable statement on this subject, he wrote Dr D. Brandis, Inspector-General of Forests in India, in the form of certain questions to be answered, as to the forests and forestry of India. Dr Brandis has kindly prepared and forwarded a comprehensive statement in answer to these questions, but as it has been late in coming to the writer, he could not well give it a place in the body of 'The Forester,' and, therefore, it is added to the work in the form of an Appendix.

With these brief remarks the Author commits the Fifth Edition of 'The Forester' into the hands of the public.

BENMORE HOUSE, PORT ELGIN,
ONTARIO, 1882.

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THE FORESTER.

CHAPTER I.

SECTION I.—A SHORT OUTLINE OF THE HISTORY OF ARBORICULTURE.

7

1. There can be little doubt that the culture of trees occupied the attention of man from the earliest ages. Though it may seem fanciful to carry back the art to the progenitor of our race, yet, when we consider how certainly these noblest growths from the soil must have attracted his wonder and excited his admiration, and how many of them must have contributed to furnish him with the means of subsistence, it is scarcely an extreme assumption that he may have devoted some degree of care to their cultivation; and if the art of gardening is entitled to claim its origin from the garden of Eden, that of forestry may, on similar grounds, claim the same antiquity.

2. Passing from this early period, we learn from the history of Solomon, king of the Jews, that he was well acquainted with the nature of plants; and we may safely infer that, in the extensive gardens and pleasure-grounds of that wealthy and intellectual sovereign, there had been no small attention paid to the rearing of trees both for ornamental and useful purposes. From his example, and from his ability to introduce many different species of trees from the countries to which his ships sailed, he would establish tree-culture to a considerable extent among his nobles and others having estates in his provinces; so that the deduction from this is, that in Judea arboriculture was practised and understood at a comparatively early period.

3. The Greeks, who were, in their day of power at least, a highly intellectual people, and who lived for the most part on a fertile soil and in a salubrious climate, would, at an early period in their history, appreciate the advantages of tree-culture both for useful and orna-

mental purposes. It is to be inferred, therefore, that they too were arboriculturists to a pretty large extent.

4. But of all the nations of antiquity the Roman was the greatest in the cultivation of trees; and of this we have ample proof from the writings of Pliny. In fact it is wellnigh certain that the Romans were the first to introduce foreign trees into Britain, as well as the first to teach our forefathers in regard to the general cultivation of this class of produce. They were, in the common sense of the word, Foresters; for we learn, from the author named above, that they planted and reared coppice-woods for poles to support their vines, and for various other useful purposes, and that they planted willows for basket-making and other wicker-work. It is also stated that they had forests on their hills, from which they cut timber for building purposes.

5. At what particular period in the history of Britain tree-culture was first commenced we have no reliable information; but there can be no reasonable doubt that the Romans were the first to introduce the art, at least to any important extent. It is but reasonable to suppose that, previous to the invasion by the Romans, the inhabitants of both England and Scotland were too rude and ignorant, as well as too much harassed by their party wars, to be able to benefit themselves by planting trees to any extent.

6. The first reliable account we have in reference to the planting of trees in Britain, is that given by Holinshed, who states that, in the reign of Henry VIII., "plantations of trees began to be made for purposes of utility." In 1523, one Fitzherbert wrote a work on planting.

7. In 'Brit. Topo.,' p. 61, Gouch says that, before the year 1597, Gerard had 1100 different plants and trees in cultivation.

8. From the date last noted up to 1664, when Evelyn published his 'Sylva,' many trees were introduced into England, and cultivated by private proprietors in their gardens and on their pleasure-grounds, and especially on those at Fulham Palace, the seat of Bishop Compton.

9. Evelyn's 'Sylva' is a voluminous work on the subject of planting and rearing trees, and his quaint way of recording his views is rather amusing. He was a chief authority on arboriculture in his day, and in his writings he enters very fully into the modes which were by him adopted in reference to planting, pruning, and thinning. From the information contained in his work, many proprietors would no doubt plant pretty extensively; and as he was a man of very considerable natural taste and ability, he would be consulted personally on the subject of which he wrote so much. He seems to have been very fond of clipped specimens of evergreens, which were in

great fashion in his day; but, from his writings in general, it is evident that he was more a promoter of the planting of valuable timber plantations than of gardening or ornamental planting.

10. From the fact of the Botanic Gardens at Edinburgh having been founded by Dr Balfour in the year 1680, it is to be inferred that about this time not only was planting in progress in Scotland, but also that a very considerable taste for botanical pursuits had risen up in the country. From the catalogue of plants grown in these Gardens about the time we refer to, and published by Mr Sutherland, their curator, in 1683, it would seem that the cedar of Lebanon had been introduced into them that year.

11. After the year 1700, it would seem that the greater number of our large landed proprietors, both in England and Scotland, began to plant on a somewhat large scale. Brown—well known by the appellation, " Capability Brown "—laid out and planted many places between the years 1730 and 1760. Perhaps Syon House, one of the seats of the Duke of Northumberland, may be stated as the most important of these in point of variety of kinds planted. At this place there are many fine specimens of old trees, of all the important sorts known in the country at the time of their being planted.

12. From gleanings made from old writers on the subject of planting, it is certain that, in Scotland, tree-culture had commenced to some extent about the middle of the seventeenth century. From Dr Walker's Essays we learn that the lime-tree was planted at Taymouth in 1664, the silver and the spruce firs at Inverary in 1682, the black poplar at Hamilton in 1696, the horse-chestnut at New Posso in 1709, the Weymouth pine at Dunkeld in 1725, and the larch at the same place in 1741, the English elm at Dalmahoy in 1763, the Norway maple at Mountstewart in 1738, and the cedar of Lebanon at Hopetoun in 1743. These gleanings prove that a taste for the cultivation of the various sorts of trees had sprung up among the landed proprietors of Scotland at a comparatively early period.

13. In the year 1700 there were upwards of 1000 acres enclosed and planted in the New Forest, Hampshire.

14. It would seem that in Scotland, among the first who planted trees in large masses for profitable use was Thomas, Earl of Haddington. He began to plant extensively at his seat, Tynninghame, in East Lothian, in 1705. This nobleman wrote a treatise on forest-trees, and published it in 1733. In his work he says: " I will be bold to say that planting was not well understood in this country till this century began. I think it was the late Earl of Mar that first introduced the wilderness way of planting amongst us; and very much improved the taste of our gentlemen, who very soon followed his example."

15. The wilderness way of planting, referred to by the Earl of Haddington, is simply a plantation with openings left through it, as vistas from some given point, taken, no doubt, from the English style of the time.

16. About the year 1730, the planting of trees in large masses began to be very generally practised all over the country, both in England and Scotland. I state this from my own observations on the plantations which I have inspected in the different parts of the kingdom.

17. Shortly after the date last quoted, from the great demand there was for young trees for the purpose of useful planting, nurseries began to be established for their culture. It is to be inferred from Walker's Essays that public nurseries were established in Scotland, for the rearing of forest-trees, between the years 1730 and 1760.

18. About this time one Boutcher, an Edinburgh nurseryman, wrote a treatise on the rearing of forest-trees.

19. The Kew Gardens were established in 1760, and in them there were collected specimens of all known trees; but a considerable number of years previous to this date there were several extensive nurseries in England, in which were reared not only forest-trees, but also all the foreign plants known at the time.

20. As soon as public nurseries had become so plentifully and extensively established in the country as to cause competition, and consequently to produce a supply of young trees at a reasonable rate, proprietors commenced to plant on a large scale; and it will be found that a very large portion of the existing plantations of Britain were planted in the latter part of the last century and the beginning of the present one.

21. In England there are few extensive proprietors who have not a large proportion of their older woods of from seventy to one hundred years' standing, and of their younger ones from fifty to sixty years, indicating that a large amount of planting had been undertaken and performed betwixt the years 1777 and 1830.

22. The same remarks are applicable to the age of the greater portion of the existing plantations in Scotland. For although the planting of trees for profitable purposes was undertaken at a much earlier date in England than in Scotland, still the proportion of plantations of this description was but small in England previous to 1777, and I think it will be found to hold good that the larger proportion has been made since that date; and in making these statements I do so from my own observations.

23. In the latter part of the last century, and in the beginning of the present one, the chief planters in Scotland were the Duke of Atholl, Lord Breadalbane, and Sir J. Grant of Strathspey. No doubt

others planted also extensively in a comparative sense, but the plantations of any one of those just named far overbalanced those of any other private proprietor, perhaps, in Britain.

24. After 1830, and until about 1845, it would seem that comparatively a small extent had been planted. This circumstance in the history of Arboriculture is, in my opinion, to be accounted for chiefly from the fact that a large portion of the plantations which had been made previous to the date last named had not succeeded to expectation; and that, consequently, not only the proprietors who had so nobly set an example in this respect, but also others who purposed to plant, were deterred from their praiseworthy exertions to improve the country, from seeing the generally unremunerative success which followed so great an outlay of capital.

25. That partial failure should have followed upon extensive planting, at a time when the advantages of drainage and thinning were not properly understood nor acted upon, is not to be wondered at. But gradually, and as experience was obtained on the subject, light was thrown on it, and a new era was brought about. This era, I should say, may be dated from about the year 1845, as previous to this period few had practised drainage to any important extent on land before planting trees upon it, and as few had understood the necessity and advantages of judicious and systematic thinning.

26. After the year 1845, when the partial drainage of waste and other lands began to be practised for the planting of forest-trees, and when even the imperfect system then adopted was found to operate in a beneficial manner on the health of the crop, many proprietors, especially in Scotland, commenced to plant largely.

27. Some time previous to the year 1845 the advantages of thinning young plantations in a decided and systematic way had become somewhat understood, but even then much remained to be learned by those who had the management of them. Within the last thirty years, however, great improvements have been effected in this respect; and now, in 1880, the greater part of those engaged in forestry have learned to understand thinning on sound principles, and to act upon them.

28. Within the memory of the writer vast advances have been effected in the mode of cultivating trees, from the results of which proprietors are now expending, with full confidence of realising valuable returns, large amounts in the improvement of their properties by planting; and as the subject has now become one of the greatest importance to this country, in a profitable point of view, it cannot be doubted that ere long still greater improvements will be brought out in reference to it, and consequently, that still greater advantages will arise from them than have yet been experienced.

29. Since the beginning of the present century, a large number of new sorts has been added to our list of forest-trees, chiefly from the mountainous regions of India and America. Many of them, especially of the pine and abies tribes, are doubtless destined to become of very great importance to the country, both in a useful and ornamental point of view.

30. Many public-spirited proprietors have planted collections of the newer sorts of trees upon their grounds, in order to test their hardiness and suitableness to our climate. From such praiseworthy exertions we are now in possession of ample experience in regard to the characteristics of the several species, and consequently are able to discard such as have proved unsuitable, and to promote the increase of such as are likely to be of advantage to our plantations.

31. Looking to other countries in respect to Arboriculture, we find that, in the middle and western States of the North American Union, planting is being undertaken on an extensive scale, not only with trees natives of the country, but also with kinds introduced from Europe. In Australia, also, planting is now performed on a large scale, especially in South Australia. Here extensive fields of the natural forests are being conserved, and the unoccupied portions of the land embraced planted, not only with the native sorts of trees, but also with species introduced from Europe, India, and America,—all of which succeed well in the climate, and promise to become, in due time, highly valuable, both in respect to improving the climate and as timber. Besides, in India, extensive operations are now being undertaken in respect to thinning and planting. Here many species are being introduced from Australia, America, and Europe, which are planted along with the native kinds,—all doing well, and promising to become, in every respect, highly valuable to that country.

32. Judging from such undertakings, it does not admit of a doubt that Arboriculture, as an art, is fast attaining that degree of perfection which its importance demands as a branch of rural economy.

SECTION II.—IMPORTANCE OF WOODLANDS IN ANY COUNTRY.

33. The cultivation of woodlands, as a source of profit, is of equal importance to the welfare of every country. In any country thinly inhabited by man, natural forests generally prevail in great abundance; indeed, often to such an extent that the new settlers find forests of timber-trees to be a mere nuisance, and are very frequently obliged to destroy them, in order to have the land put under a crop more profitable for their purpose for the time being. We are aware that this is the state of things relative to forestry in many districts

of a newly settled country, but it is ultimately a very unprofitable way of going to work, even in a country where natural forests prevail; for, were forestry maintained as an art among settlers in a new country, much profitable and useful timber might be retained upon the newly improved lands, which might prove of great advantage to generations coming after, as well as to the settlers themselves; and, as an example of this, witness the scarcity of useful wood in a great part of the United States of America at the present day. The inference is, that the raising of artificial forests in any newly inhabited country is not of primary importance to the settlers; but the retaining a part of the natural forests is of great ultimate importance to them, and provision should be made by the laws of such a country for preserving a proper quantity of the natural forests for ultimate good. But the case is altogether different in an old established country, where the natural forests have for the most part disappeared, and where the inhabitants must either buy timber from other countries, or raise it on the land in the form of a crop.

34. The mining operations of a country demand extensive woodlands to support them; the maintenance of railways as urgently calls for this; the present advanced state of agriculture demands the same thing; and it may be truly said that the general welfare of any highly civilised country cannot be maintained without an extent of woodlands suitable to its circumstances and demands.

35. The policy of depending upon foreign countries for the supply of timber for national industries is a short-sighted one, and therefore ridiculous in the extreme, and more particularly when there is so much waste land in most countries, of excellent capabilities for the growing of timber, the greater part of which is inaccessible or worthless to the plough of the farmer, and therefore would by no means diminish the available quantity of land which might be improved for the increase of food for the population.

36. Many argue that there is no need for planting waste lands with trees so long as a full supply of timber can be had from foreign parts. But those who say this have not considered that every country upon the face of the globe is rapidly progressing in the march of improvement. It is well known that, as civilisation makes progress, and agricultural pursuits extend, natural forests diminish, and eventually become extinct—as is the case with Great Britain at the present day; and at the same time, as civilisation increases, the demand for timber increases also. Now we must infer from this that each country, as it becomes more refined in the arts and comforts of life, will have at least enough to do with its own home timber, and will require to encourage forestry in order to keep good its own supply.

37. We may further add that, at the present day, the United

States are depending upon the wooded regions in Canada for the supply of their useful timber; and in that country, where so much wood is necessarily consumed for fuel, the supply cannot meet the demand for many years; and it is now the opinion of many who are well acquainted with the subject, that in a few years wood will not only be very scarce, but at the same time very dear—much beyond any price we can form an adequate idea of at the present day. But it is to be hoped that these matters will undergo serious consideration, in order that such a state of things may be in a great measure avoided; and the remedy is, an improved and extended system of forestry throughout the whole of the civilised nations of the world.

38. The present advanced state of agriculture everywhere demands a skilful and extended system of forestry.

39. It is allowed by all who have given their attention to the improvement of lands in any country, that the rearing up of healthy plantations improves the general climate of the neighbourhood; and not only is the climate improved to a great degree, but the very soil upon which forest-trees grow is much improved by the gradual accumulation of vegetable matter from them.

40. We would ask this plain question, What is the natural cause of so much waste land being found in the north of Scotland, and in many parts of England? Can it be denied that it is the want of trees to give shelter? Why is it that proprietors of land in these parts complain so much of great tracts of it being worthless, growing nothing but the inferior grasses, mosses, rushes, and heaths, upon which even one sheep cannot find food upon two acres? Is it not for the want of plantations to give shelter? Now that agriculture is improving rapidly everywhere, forests and extensive plantations ought to go on in the same degree—not keeping behind, but rather in advance; for what profit will be derived from a superior system of cultivation in the land, if the fields we cultivate be not sheltered from the evil effects of uncongenial climate by healthy and judiciously laid-out plantations? In the improvement of all waste lands there ought to be a large proportion of the same planted, in order to give shelter; and wherever this is not attended to, disappointment is the natural result: for if this be not done as the improvement of waste lands advances, these will, without doubt, be comparatively unproductive; and very likely, from the holder of such land finding that it does not pay him, he will allow it to fall back into its original state of nature.

41. It is a well known fact that, in both Canada and the United States, the yield of the wheat crop gradually diminishes as the forests are cleared, and that the heaviest crops of this cereal are found on land sheltered by woods.

42. The general welfare of the country demands an extended and improved system of forestry.

43. If the population of a country doubles itself every fifty years, where is the supply of food to come from, in one hundred years hence, if the waste land be not improved by forestry? This is a question which demands serious consideration, and must, upon reflection, point out the influence of planting upon the general welfare of a country. If any piece of waste land, after being drained and ploughed, will yield twenty bushels per acre, in a state unsheltered by forest-trees, the same land will yield at least thirty-five bushels per acre if judiciously sheltered by them; and from this we are bound to conclude, that the inhabitants of a country have a right to expect that such a state of things should exist.

44. And not only is the community at large benefited by an extended system of improvement, but every proprietor who will plant forest-trees, not only gives shelter to his fields, but, at the same time, greatly enhances the value of his estate, as will be treated upon in the proper place.

SECTION III.—SUITABLENESS OF THE SOIL AND CLIMATE OF GREAT BRITAIN TO THE GROWTH OF TREES.

45. We think it may be stated that there are few countries in the world so well adapted to the growth of a great variety of valuable timber-trees, of foreign origin, as our island.

46. Its soil is variable, and hence its general adaptation to the healthy development of very many sorts of trees from all the temperate regions of the globe; and from our winters being generally milder than those of many continental countries considerably lower than our latitude, we succeed in cultivating, without any artificial protection, many sorts of useful plants which are not found to stand the winters of the continents of North America and central Europe without artificial means being used.

47. The comparative nearness of all the parts of our island to the softening influences of the sea is no doubt the cause of this; for the ocean invariably preserves a more uniform temperature than the land. Hence, from our island position, we enjoy a milder climate than the inhabitants of inland regions under the same parallel of latitude; and hence the temperature at London is lower in summer than at Paris, and higher in winter, although the former place is in a more northern latitude than the latter.

48. The climate of the western seaboard of Great Britain is in general milder than that of the eastern parts under the same parallel.

For example, on many places even on the west coast of the northern part of the island, the *Fuchsia coccinea*, the *Buddlea globosa*, the *Hydrangea hortensis*, the *Aloysia citriodora*, and the *Myrtle*, stand the winter without any protection, forming large and very ornamental bushes in gardens and other sheltered parts; while on the east coast parallels these plants are generally injured by frosts if not protected. Even as far north as Glenelg, in the county of Inverness, the *Fuchsia coccinea* stands the winter without protection, and forms a bush from 5 to 6 feet high in sheltered gardens.

49. The uniformity of the temperature of our climate is very remarkable as compared with that of other parts of the world; and from this we have an undoubted advantage over almost all other nations in regard to the cultivation of trees not natives. We shall refer to a few examples of places in illustration of this point. Humboldt says: "At New York, we find the summer of Rome and the winter of Copenhagen. At Quebec, grapes sometimes ripen in the open air, whereas the winter is that of Petersburg, during which the snow lies five feet deep for several months, and travelling is performed in sledges, frequently on the ice of the St Lawrence. At Pekin, in China, where the mean temperature of the year is that of the coasts of Brittany, the scorching heats of summer are greater than at Cairo, and the winters as rigorous as at Upsal."

50. But, apart from all such mere deductions as regards the mildness of our climate, we have the more convincing proof of our own experience on the subject; for there are not many countries in the world from which we have not brought plants, and cultivated them either as useful or ornamental—and a large portion of them, not by confining them in an artificial climate, but by planting them in the open ground, and exposing them to all the changes of our climate. For example, from the south of Europe we have the lime-tree and black poplar; from Corsica, the *Pinus laricio;* from Austria, the *Pinus Austriaca;* from Germany, the common larch; from the north of India, the horse-chestnut; from Eastern India, the *Cedrus deodara;* from Asia Minor, the sweet-chestnut; from the United States, the *Magnolia grandiflora* and the tulip-tree; from Canada, the *Populus Canadensis;* from California, many useful pines; and from Chili, the *Araucaria imbricata.* These few examples, out of the many that could be adduced, are enough to show that both the soil and the climate of Great Britain are admirably adapted to the growth of trees; and not only those which are natives of Europe, but also such as are natives of temperate regions in all parts of the world.

51. Notwithstanding, however, that the soil and climate of our island are generally thus suitable to the healthy growth of a great variety of useful trees, natives of foreign countries, it must not be

understood that all parts of it are alike in this respect, as there is, in the length and breadth of Great Britain, a very considerable diversity in regard to both soil and climate; and this is, of course, to be expected from the different geological formations, as well as from the different degrees of latitude and relative elevations of land embraced betwixt Land's End and the Pentland Firth.

52. The great central and eastern plains of England, together with the Valley of the Severn, may be classed as the first in order for the growth of the most valuable sorts of trees to first-rate magnitude in this country, and the plains of York and Cheshire as the second; while the great table-lands situated to the south-west of these districts may be characterised as third-rate, as compared with the others, for growing trees of the hard-wooded sorts; and the table-lands of the north of England and the south of Scotland, embracing that district of the island from the river Tees on the south to the Firth of Forth on the north, as fourth-rate, both in respect to soil and climate.

53. Lying partly on the north of the Firth of Forth, and partly on its south side, there is the narrow central plain of Scotland, stretching from Glasgow along both sides of the river Forth to Edinburgh, and thence northwards as far as Montrose, which, for the growth of trees, may be classed as of fifth-rate capabilities.

54. With the exception of the low-lying lands situated on the sides of the Moray Firth, which may very properly be classed as of sixth-rate capabilities for the growth of trees, the greater part of the country situated to the north of the central plain of Scotland, both from its geological formation and from its relative altitude, is, generally speaking, unsuitable to the growth of any trees to large and valuable dimensions other than the pine and fir tribes; but these on this district of the island grow to even more valuable sizes than in the more southern parts. Hence this may be truly styled the pine-growing region of Britain.

55. The larch-forests of the Duke of Atholl at Dunkeld, and those of the Marquess of Breadalbane at Taymouth, may be cited in illustration of the suitableness of the soil and climate of those districts in particular, and of the West Highlands in general, to this most valuable tree; and the pine-forests of Glenmore, Rothiemurchus, Glenmorriston, Abernethy, Duthill, and Braemar, are evident proofs of the suitableness of the soil and climate of these inland parts of the island to the growth of the Scots pine to its most valuable dimensions.

SECTION IV.—SUITABLENESS OF THE SOIL AND CLIMATE OF CONTINENTAL EUROPE TO THE GROWTH OF TREES.

56. On the continent of Europe there is a very great variety of soil and climate; this field embracing plains and valleys of the richest character of soil, while there are hills and mountains of the most sterile nature.

57. In Spain, Portugal, Italy, France, Austria, and Turkey, all the trees natives of Europe, South Africa, North America, southern Australia, and northern and central Asia, find suitable homes, both as to soil and climate, and prosper luxuriously; while in Germany and the southern parts of Russia, many of the kinds which luxuriate in the more southern countries named do not succeed, from the severity of the climate in the winter season.

58. In the cold regions of northern Europe, embracing Norway, Sweden, and Russia, only the common sorts of trees grow well—such as the Norway spruce-fir, Scots pine, oak, ash, beech, elm, lime-tree, and birch.

59. On the continent of Europe, as stated above, the soil embraces all varieties, while there are various conditions of climate, from that of sunny Italy to snow-clad Sweden, and from this it is to a very large extent well adapted to the healthy growth of a great number of species from foreign countries.

60. The climate in the middle and southern parts of Europe being drier than that of Great Britain, insures the more thorough ripening of the young wood of foreign species than is generally obtained in England and Scotland; and from this many foreign sorts which succeed in the south of Europe do not live in the open air of Britain.

SECTION V.—SUITABLENESS OF THE SOIL AND CLIMATE OF THE NORTH AMERICAN STATES TO THE GROWTH OF TREES.

61. There is no country in the world so well adapted to the healthy growth of a great number of species of trees as the great region possessed by the people of the North American States.

62. Looking at the country in its length and breadth, it embraces every variety of soil and climate that an arboriculturist could wish; and in which—keeping out of view the native sorts—trees from nearly all parts of the world may be found luxuriating as in their native habitats.

63. In the southern parts of this country, and on the Pacific side, the trees of India, Australia, and Africa prosper remarkably well,—the Eucalypti of Australia generally making growths, in one year, of from 4 to 6 feet, while species from Africa and India make proportional progress.

64. The central parts of the country, from their having somewhat severe winters, are not adapted to grow so many foreign species as are found to succeed on the southern and western parts; still here, besides the native trees, many of which grow to great size, all the trees of Europe grow luxuriantly, and generally to greater dimensions of timber than in their native sites.

65. In the northern and eastern States, from the winter climate being severe, only the hardier species of foreign trees succeed well, and these are chiefly from northern Europe and Asia. Here, however, the native trees are excellent in all respects, producing timber of great dimensions and of the best quality.

66. In the northern and eastern States very few of the trees, natives of the southern and western States, succeed well; thus showing the great difference there is in the climate of these parts respectively.

67. From what has been stated above it is to be inferred that, from the United States embracing so many degrees of latitude, and relative elevations of land, a great diversity of soil and climate must exist. With some exceptions, the soil of the United States of America, from its great variety of geological formations and relative elevations, is, without doubt, unsurpassed for the growth of a great variety of trees; while the diversity of climate is equally favourable to this.

SECTION VI.—SUITABLENESS OF THE SOIL AND CLIMATE OF CANADA TO THE GROWTH OF TREES.

68. In referring to Canada we mean to embrace the whole of British America, from the Atlantic to the Pacific. Here there is a great variety of soil and climate; but from this portion of North America lying on the north of the United States, its climate is colder, and therefore less suited to the growth of many foreign trees.

69. On the Pacific slope, and especially in British Columbia, there are vast forests of native trees, and particularly of the *Abies Douglasii*, *Cupressus nutkaensis*, and *Sequoia sempervirens*, and various species of *Picea*, showing that the soil and climate of this portion of Canada are as suitable to the growth of these fine trees, as are these conditions in Northern California. Therefore British Columbia may

be said to be well suited to the growth of many trees natives of foreign countries, and especially to those of Europe and northern Asia, and to those of the northern States adjoining on the south.

70. All the country stretching from the Rocky Mountains eastward to Hudson's Bay and the Ottawa River, and northward to the 60th degree of latitude, is well adapted, in respect to both soil and climate, to the healthy growth of all the trees natives of North America, from the 40th degree of latitude.

71. As already stated, the soil and climate of Canada are excellently suited to the healthy development of most of the useful trees of Europe; and in proof of this we may mention that the European larch grows fully better here than it does in Great Britain, and attains a larger bulk of timber within a given time; while the Scots pine, the Austrian pine, and the Norway spruce-fir thrive equally well. Many of the hard-wooded sorts, natives of Europe, also prosper well in Canada; and for example we may mention the common sycamore, the Norway maple, the horse-chestnut, and many others.

72. To the east of the River Ottawa, the climate is colder than in the parts we have referred to above, and therefore is suitable chiefly to the native sorts of trees; still some of the hardier kinds of European trees succeed well.

73. From what has been stated, it is to be understood that all the southern portion of Canada is well adapted to the healthy growth of a considerable variety of useful trees natives of foreign countries, and that the northern and eastern parts are too cold to grow satisfactorily any other than the native sorts.

74. The present crop of the natural forests of Canada is a proof of the suitableness of the soil and climate of the country to the growth of trees to very large dimensions. No country in the world has a greater bulk of timber on the acre than is to be found in Canada.

SECTION VII.—SUITABLENESS OF THE SOIL AND CLIMATE OF AUSTRALIA TO THE GROWTH OF TREES.

75. This great country, extending between the parallels of 12° and 40° S. latitude, embraces many conditions of soil and climate, from the rich loam of the level plains, where the heat is excessive in the summer season and where snow seldom falls, to the poorer soils of the hills and mountains, which are of various heights up to 6000 feet above the level of the sea, where the climate is comparatively cool even in summer, and where snow lies on the higher parts.

76. The native trees of Australia are of a peculiar character, and nearly all of them are evergreens—the change of the season producing no apparent influence on the olive-coloured tint of the forests.

77. The native timber-trees consist chiefly of Eucalypti, and of this genus there are many species, some of them attaining heights over 300 feet, with proportional diameters. Casuarinea and acacia are also common.

78. In some parts of this great country there are large forests of the trees named, along with other genera of less importance; but, generally speaking, the native forests are not extensive, compared with the extent of the country.

79. Both soil and climate, however, are well adapted to the healthy growth of trees from all parts of the world, and in proof of this, it may be remarked that already very many species have been introduced from India, Africa, America, and Europe, all of which are prospering satisfactorily.

80. On the hills here all the coniferous trees of California are found to prosper well, and also those of Europe and Asia, while the deciduous sorts of these parts of the world succeed equally well.

81. The governments of South Australia, New South Wales, and Victoria are devoting great attention to the rearing of trees of all sorts from foreign countries, and wherever these have been planted on suitable soils they are succeeding satisfactorily.

82. In South Australia several hundred thousand acres have been conserved, and put under the charge of a board, with a conservator to attend to thinning and planting; and here large extents in different parts of the province are being planted every year, so that ere long this country must become well wooded, with all the useful kinds of trees from the countries named above.

SECTION VIII.—SUITABLENESS OF THE SOIL AND CLIMATE OF NEW ZEALAND TO THE GROWTH OF TREES.

83. The surface of New Zealand is a series of mountains, hills, valleys, and plains; the mountains on the north island rise to a height of 9000 feet, while on the south island they rise to the great height of 13,000 feet. On the lower slopes of the mountains and on the hills there are dense forests of the native trees; while the valleys and plains are also, generally speaking, well wooded, with extensive grassy ranges between the wooded portions.

84. In a country having such a diversity of surface as this one has, it is to be expected that there is also a great diversity of soil and climate. And this indeed obtains,—as in the valleys and the

plains the soil is of a very rich character, with a most congenial climate; while on the hills and on the lower parts of the mountains the soil is very variable, with a comparatively cool climate; and on the middle zones of the higher mountains the soil is generally, though not rich, yet very favourable to the growth of both coniferous and deciduous trees.

85. In this country snow seldom lies at the level of the sea; but all the year round it lies on the summits of the mountain ranges, and when frost occurs on the plains and valleys it is very slight.

86. From what has been stated above, it is to be inferred that the soil and climate of New Zealand are well adapted to the healthy development of very many sorts of trees, natives of foreign countries, and this has been proven from actual experience.

87. Most of the timber-trees of Europe have been introduced into this country, and also many species from Australia, and a few from America,—all of them growing well, and thriving as well as in their native sites.

88. Planting has already been undertaken to a considerable extent by the settlers on many parts of both islands of this country; and the trees used are partly of the most useful sorts of the native timber, together with a large proportion of the European coniferous and deciduous sorts; and from this it is evident that the soil and climate of these islands are well suited to the growth of many species of foreign trees, and that ere long the country will become well clothed with the most useful trees of Europe and other foreign parts, so as to obviate the necessity of using the native timber, which is generally much inferior to that of trees introduced from foreign parts.

SECTION IX.—SUITABLENESS OF THE SOIL AND CLIMATE OF BRITISH INDIA TO THE GROWTH OF TREES.

89. The whole of British India, south of the Himalaya mountains, is unrivalled for its trees and other plants; many of the trees attaining vast dimensions, and producing timber of the best quality. Among these may be mentioned the teak and the cedar of India.

90. The mountainous regions of Northern India have a temperate climate, while in the central and southern regions the heat is very great, producing palms and other tropical trees in great abundance. Here, as is to be expected in this vast region, the soil varies from the richest found on the globe to the poorest on which vegetation can well succeed.

91. Every one knows that the soil and climate of India are, generally speaking, highly suitable to the growth of trees from all

parts of the world,—its native trees of all sorts attesting this. Here there are all conditions of soil and climate to be found on the earth, from the tropical to the arctic, thus securing suitable sites for the healthy development of trees from all countries, whether tropical or temperate.

92. A large portion of the native forests of India are being conserved by its government, and systematically attended to by a qualified staff of foresters. And not only are the existing crops of the native woods being improved, but also large extents are being planted with trees both native and foreign, so that in due time it is to be expected that India will become judiciously clothed with the most useful of the timber-trees of Asia, Africa, America, Australia, and Europe.

SECTION X.—SUITABLENESS OF THE SOIL AND CLIMATE OF SOUTH AFRICA TO THE GROWTH OF TREES.

93. South Africa has a soil and climate excellently adapted to the growth of trees from foreign countries; as here there are many of the trees of Australia, especially the Eucalyptus and acacia, growing as well as if they were in their native habitats.

94. The surface of the country is very varied, and consists of a series of plateaux, rising in successive terraces from south to north, and separated by mountain chains; a few of the summits of the mountains rising to heights varying up to 9000 feet. This character of surface gives rise to a great variety of soil and climate, suitable to the healthy development of trees from many foreign countries.

95. This country is, generally speaking, not well wooded with native trees, although the soil is for the greater part well adapted to the growth of trees of every sort. Still, there are here and there native forests of considerable extent.

96. A considerable extent of land has been planted here and there however; and the success of these crops is an evidence of the suitableness of the country for the rearing of timber to valuable dimensions. The kinds planted are chiefly oak, poplar, cluster pine, and stone pine, with ash, elm, and sycamore; all of which have made rapid progress. The Indian cedar, the mahogany, and banyan trees thrive well also, thus proving the capabilities of the climate.

97. The general dryness of the climate of this part of Africa renders it highly necessary that planting should be undertaken largely; as were this done, the climate would be in due time much improved.

SECTION XI.—THE EFFECTS OF PLANTING, AND ITS INFLUENCE ON THE IMPROVEMENT OF THE SOIL AND CLIMATE OF A COUNTRY.

98. The first and perhaps the greatest effect of judicious planting is that of shelter to the country in its neighbourhood.

99. The second, and perhaps not the least important effect of planting trees in masses, is that of ornament.

100. When we compare the agricultural and picturesque advantages of a part of the country which is judiciously clothed with trees with those of a part which has either been stripped of its crop of timber, or which has never been planted at all, the difference is very striking, even to the most common observer. In the former all kinds of crops are sheltered, and consequently grow luxuriantly; while in the latter the crops are subject to the extremes of cold and storms in winter, as well as of the sun's heat in summer.

101. It is therefore an undoubted fact that the presence of trees in any country has the effect of softening the storms and colds of its winters, as well as of softening the heats of its summers, and preventing too great evaporation of moisture from its surface, which inevitably takes place under a contrary state of things.

102. The drying effects of the absence of trees are exemplified on a large scale in North America at the present day, wherever the axe of the settlers has been in operation for a considerable length of time. There we have ourselves seen the beds of former water-courses ploughed, and only observable as such by their hollow lines running through the farms. The settlers told us that when they first came into the forest these hollow lines ran with a never-failing supply of water, and that they gradually became dry as the woods were cleared and the land subjected to the plough and the hot rays of the sun. Hundreds of families that we have visited in British North America have told us that they had been obliged to change the sites of their original locations, simply because the streams, on the sides of which they had sat down, expecting to have an unlimited supply of water, had dried up as they cleared the land of its tree crop.

103. But we need not go out of Britain for proof of the drying effects of injudicious clearing of forests on the land. In our own experience in dealing with woodlands we have seen, after a large tract of wood had been cleared from the hillside, springs which had, while the land was covered with trees, yielded a constant supply of water, completely dried up; and there are many who can attest this from observation in respect to similar cases in their own parts of the country.

104. On the other hand, we have frequently been surprised to

find, on examining woods which had been planted some ten or twelve years, all the land under which had been considered dry at the time the plantation was made, wet spots, spreading wider and wider every year, and some of them even beginning to throw out runs of water; thus proving, that under the shade of the trees the larger portion of the moisture of the land is retained, and therefore accumulates in spots according to the nature of the subsoil.

105. The general effect produced by high hills and mountain-ranges on the moisture of the air can be made good to the lower-lying and level parts of a country by careful attention to the distribution of its forests. Woods and plantations, in all cases, collect large supplies of moisture from the air. The roots of the trees composing them loosen the soil, while the herbage growing under the shelter of their branches prevents the rain-water, even on sloping hillsides, from running quickly off. Plantations in all cases check the currents of air passing over a country, and from this cause the carrying off of its moisture by drying winds is greatly lessened. The shade of trees prevents the rays of the sun finding their way to the soil, so that but little of the moisture in it can be licked up for the warm currents to carry to the upper air.

106. The water sucked up from the earth by roots of trees is given off again by the twigs and leaves in the form of vapour—hence the air in plantations is always found moister and cooler than it is in the open country, where the land is destitute of trees. Therefore it follows that while the warm air is rising upwards from the dry land of the open country, the cooled and moister air must fall again to the still cooler surface of the woodland; and therefore, in the neighbourhood of masses of plantation, there are all the conditions secured for the fall of moisture from the air in very much greater force than over the open fields.

107. When soft winds, charged with vapour, blow over dry ground heated by the sun, no fall of wet usually takes place, but, on the contrary, the clouds that are formed sink down into the warm air below, and are soon dissolved and vanish. The dried and warm soil drives the rain away, so to speak. It is not so, however, where the temperature is softened down by the influence of woods. There the air is loaded with moisture, from the constant evaporation, and soon becomes overcharged by the falling clouds, and so rain follows.

108. From a consideration of the facts adverted to in the foregoing remarks, it appears evident that it is in the power of man to alter, modify, and regulate the climate in which he lives to suit the various kinds of crops he cultivates in different localities, and this by the distribution of plantations of various extents to suit the particular circumstances of the case. In our present state of knowledge, however,

we are unable to accomplish this. To attain to this, and to bring forestry to the standing of a climatic science for everyday guidance to all interested in rural economy, it is necessary that some well-regulated system for united experiment and observation on the subject should be established by a body, or bodies, of scientific and practical men, who could act together in carrying out experiments in all countries, and in various parts of each country, with the view to bring forestry to the position its importance demands for the improvement of climate in all parts of the habitable globe. This is a work that should not be delayed, and which all should lend a hand in, but more especially landed proprietors, their agents and foresters. The scheme proposed embraces the climatic improvement of all countries on the face of the earth; and if well gone about, it cannot fail ultimately to add greatly to the health of mankind, and to promote and develop the latent resources of all countries in an incalculable degree.

109. Having thus shown that judicious planting has a very decided influence on the improvement of the climate of a country, we now come to make some remarks on its influence to improve the soil; and on this branch of the subject it may not be too much to state that any piece of land, not properly agricultural, but adapted to the growth of timber only, however good it may be previous to its being put under a crop of trees, must be very much better, chemically speaking, after such a crop shall have been reared on it and removed from it, and must thereby be rendered more suitable for agricultural purposes than if it had remained without any such crop.

110. This results from the large amount of vegetable matter which trees annually deposit on the land occupied by them, as well as from their roots penetrating deep into it, and consequently dividing its parts and opening it up to the action of air and water.

111. In proof of this we may allude to the very rich soils of the American continent, which have been for the greater part formed from the deposits of vegetable matter from successive crops of trees that have grown on them. And with these let us compare the sterility of such parts of a country as have not been occupied by trees. By such a comparison we are at once forced to admit that in the economy of nature trees perform a very important part in improving the land on the surface of the globe, and in rendering it serviceable for cultivation by man.

112. But in this respect we need not go far for proof, inasmuch as on our own island we have abundant evidence of the fact that trees vastly improve the land on which they grow.

113. On the flats and hollows of this country, everywhere the land bears evident proof of having been occupied by trees at an early

period; and that it is chiefly from this, and from their having decayed and rotted upon them, that their soil is now so fertile.

114. But, besides these proofs on this point, we may state that we have in our own day seen large tracts of waste land planted, which, although previous to its having been put under trees was thin of soil and poor, gradually became comparatively good land, and this from the decayed leaves falling from trees growing upon it, and from their shade causing the natural plants of the surface to decay and incorporate with the original soil.

115. Still farther, there can be no doubt that judicious planting on an extensive scale is destined to be the great means of improving the soil and climate of all countries.

SECTION XII.—THE OBJECT OF PLANTING.

116. Generally every proprietor, in planting trees on his estate, has some definite object in view for the work. This may be either to give shelter to his farms, to shut out some unpleasant object from his dwelling-house, or to produce ornamental effect to the landscape; but the great and ultimate object is that of its being profitable as a crop in a money point of view. In short, the object may be one or other of these points, or it may be all of them combined, according to the circumstances of the case.

117. On properties situated in naturally level, fertile, and sheltered parts of the country, where arable land is more immediately remunerative than woodland to the proprietor, he can have no object in planting trees other than for ornamental effect, or it may be for the increase of moisture in the neighbourhood.

118. The case, however, is somewhat different in regard to the proprietors of partly level and partly hilly estates, as on such, besides effect, it becomes a point of wise and profitable management to plant on the higher districts, with the view to ameliorate the climate of the lower, to improve the soil of the hills, and by the timber crop to enhance the general value of the property.

119. But with the proprietors of extensive hill estates the great object in planting must be that of rearing a crop of trees on land otherwise unfit for profitable use, and therefore that of deriving from it a source of income which could not, generally speaking, be otherwise obtained from such land.

120. The foregoing remarks are only applicable to the subject under notice taken in the broadest point of view, as, specifically, each branch of it diverges into many points, each of which may become

expedient in practice, according to circumstances. For example, a proprietor having in view the planting of trees for shelter to his farms may at the same time have in view to deal with them as hedgerow timber, as belts of plantation, as coppice, as hop-poles, or as ornamental timber, according to local circumstances, and according to the nature of the land he may have to deal with. All of which modes of planting will be treated of in their proper places, and under their respective heads.

SECTION XIII.—THE VALUE OF WOOD AS A CROP UPON LAND.

121. The value of wood as a crop upon any given piece of ground, depends very much upon the treatment it may have received in its cultivation. Trees, like every other useful product of the soil, may be considerably deteriorated in value by unskilful and careless management; and they may also be greatly enhanced in value by skilful and careful management. Besides, the value of wood varies according to the nature of the land planted, and also according as the locality may or may not be conveniently situated as regards a ready market for the sale of timber.

122. However, we may here state as a general rule, which we have verified from our own experience, both in England and Scotland, that land which is from various causes unfit for high farming, will, under wood, at the end of seventy years, under good management, pay the proprietor nearly three times the sum of money that he would have received from any other crop upon the same piece of ground.

123. This assertion, we are aware, will be considered extravagant by many proprietors; but to those who may consider what we have here said as beyond the truth, we beg to say, that although it may be in reality beyond what they have themselves experienced as to profits arising from their plantations, yet in all cases where good management has been introduced, what we have said will be found a practical truth; and in order to illustrate the point, we shall here give a few examples, without going into detail, most of which have come under our own experience in dealing with woods in different parts of the country.

124. On three estates that we have had to deal with in the north of Scotland, where the woods are chiefly larch and Scots pine, and where regular accounts of the sales of the produce had been kept for a period of nearly forty years previous to our visiting them, we found that, taking the older class of the pine woods, they had yielded, on

the average, about 13s. per acre per annum for thinnings during the forty years accounts had been kept of sales from them; and that, where clearings had been made of these, the matured crops had realised, on an average, about £70 per acre, after the removal of all the thinnings that had from time to time been taken from them.

125. The larch portions of the crops on these estates realised about one-half more than the pine portions—that is, the average annual value realised from the thinnings of the larch was, for the forty years referred to, 20s. per acre; and where clearings had been made of this kind, the matured crop had yielded £106 per acre on the average.

126. The annual rent of the land, at an average, upon which those plantations grew, was reckoned at 4s. 6d. per acre; and the crops, when matured, had occupied the land for a period of about seventy years. Now, had it been occupied by tenants for the purpose of grazing, the proprietors would have received only £15, 15s. for an acre during the period of seventy years; but being occupied by trees, we see that they received, by the end of the period of seventy years, when the crops were cleared, no less than 27s. 6d. for each year of the period in respect to each acre of that occupied by the pine crops, and about 41s. 6d. for each year in respect to each acre occupied by the larch. Now, even after deducting every necessary expense the proprietors were put to, and after deducting compound interest upon the original outlay and rent, progressively, during the time when no return was received, it will be found, as we have formerly stated, that such land, when planted with trees, will pay fully three times the amount of money that it could do in the hands of farmers; and this points out that wood, as a crop, even when managed in an ordinary way, is exceedingly profitable to the proprietor, and adds greatly to the value of his estate.

127. Next, in the south of Scotland and north of England we have seen the matured crops of larch sold at prices ranging from £150 up to £380 the acre, and this irrespective of the value of thinnings that had been removed from them during their young and growing stages. The land on which these crops grew was valued at rates varying from 10s. to 15s. per acre per annum, and the crops when cleared were of from sixty-five to seventy years' standing.

128. We may here mention that in the north of England a crop of matured larch was sold some time ago at the rate of £500 per acre. We have this information from a well-informed forester, who lives in the neighbourhood of the estate where this high sum was realised, and whose information is to be relied on. He says this crop grew on a sloping bank unfit for the plough.

129. In the south of Scotland and north of England we have seen

crops of matured Scots pine sold at rates, per acre, varying from £65 up to £200. The age of these might be about seventy-five years on the average, and the rent of the land about 15s. per acre.

130. In the same parts of the country we have seen matured crops of mixed hard-wooded plantations sold at rates varying from £80 up to £170 per acre, and in one or two cases as high as £220.

131. Again, on the same parts we have seen matured crops of oak sold at prices, per acre, varying from £200 up to £400.

132. In the cases referred to under the five preceding paragraphs, it must be kept in view that no account is taken of the thinnings which had been removed from the several crops while they were in the growing state, and before they became matured, as any information in regard to that source of income could not be obtained.

133. What we have said above refers to the value of a crop of wood when trained up as timber-trees. There are, however, many proprietors who cultivate a large portion of their woodlands upon the principle of coppice-woods, which are growths from the stocks of trees formerly cut over; and as to the value of this class of crop, it will suffice to say that it does not, as far as our experience goes in dealing with it, pay nearly so well as a crop of timber. We have had to do with this class of crop on places in the west and south of Scotland and in the central and northern counties of England, and have seldom found it pay the proprietor over 15s. per acre per annum for the land it occupied.

134. These examples we consider quite sufficient for the present purpose. We might, indeed, give many others in illustration of the point under notice, but as they would only go to swell this work without altering the facts stated, we think it preferable not to do so. But we may add that it is not alone the simple value of the timber that makes plantations of so important a nature upon a gentleman's property: there is the shelter that they afford for all agricultural purposes, and their beneficial effects in regulating the climate; for where no plantations exist, there is invariably an inferior crop of grain upon the fields, as well as an ill-fed live-stock, which should all be taken into account. We are, indeed, of opinion that, upon any landed property, well-managed plantations are incalculably of more value than land three times their extent in the hands of a farmer, but without trees to give shelter; and it is well known by every proprietor of land that he receives by far the highest rent for those parts of his lands which are most sheltered by his best plantations. And further, of whatever value land may be in the hands of a farmer without plantations to give shelter to it, it is of very much greater value when properly sheltered by them.

SECTION XIV.—THE CONDITION OF FORESTS AND PLANTATIONS AS GENERALLY EXISTING IN GREAT BRITAIN.

135. The forests and plantations of this country may properly be divided into two classes—namely, PUBLIC and PRIVATE. By the former we mean those belonging to our Government, the principal of which are the New Forest, in Hampshire; Dean Forest, in Gloucestershire; Delamere Forest, in the county of Chester; and the forests of Bere, Alice Holt, and Woolmer, in Hampshire, in which the professed object is that of rearing timber for purposes in connection with Government works. By the latter we mean those belonging to our landed proprietors generally, in which the crops are reared with the view of their being made available for shelter and ornament to the estates, and as sources of private income to their holders. With regard to each of these classes we shall make a few remarks descriptive of their general condition at the present time.

136. The land under trees in the several forests named as belonging to Government is said to extend to about 40,000 acres, and the crop cultivated is oak chiefly, with a small proportion of the other kinds, usually planted on spots of land considered unsuitable for the growth of oak; and the trees are of various ages, from those of matured growth down to a few years planted, but the larger extent of the crop may be said to consist of trees in a young and growing state.

137. Previous to 1852 nearly all the crops in these forests had been much neglected in the way of thinning and draining, whereby their healthy and full development had been arrested; but since that date great improvements have been effected in dealing with them, and now systematic thinning is carried out, and attention paid to keeping the land in a dry and healthy condition—so that, looking to the future, there is every prospect of a crop of fair value being raised in these forests.

138. With regard to the woods and plantations of private proprietors of this country, both in England and Scotland, we are glad to be able to state that their condition, generally speaking, is very much improved within the last thirty years. Previous to 1850 the greater part of the woods and plantations on private properties, in all parts of the country, was in an unsatisfactory condition both in respect to drainage and thinning, but since that date vast improvements have been effected; and now we find, on most estates, that thinning and draining are being carried out systematically, with the view of promoting the better health of the older class of plantations,

and that before planting is undertaken on any piece of land, the fitness of its condition for the growth of trees is duly considered, and the kinds are selected which are likely to succeed best on the soil and site.

139. On examining the older class of plantations upon private properties, it is at once evident that a very large extent of them still consists of trees that have been planted on land not suited to the crops respectively. In consequence of this, a large proportion of them has been cleared of late years and the land replanted with crops suited to it. The process of clearing the unhealthy portions of the crops has, generally speaking, been judiciously undertaken and carried out, so that the breadth of those plantations which are unhealthy from the cause stated is gradually becoming less and less, while the extent of land under young and healthy crops is annually and rapidly on the increase.

140. In speaking of the younger class of plantations—say those under 30 years' standing—we are glad to say that generally they are in a fair state of management, and promise to become valuable in due time.

141. There is a greater degree of intelligence now brought to bear on the general management of all classes of plantations, on nearly all properties, than was put into exercise some thirty years ago; and from this encouraging circumstance it is fairly to be deduced that forests and plantations, as generally existing in Great Britain, are greatly improved and in a more promising condition than they were then, and that, consequently, there is good reason to conclude that now that the tide of improvement has fairly set in on this department of rural economy, it will immediately receive those invigorating attentions it deserves from science and wealth, and become ere long equally important to the welfare of the country with the sister arts of gardening and farming.

SECTION XV.—GLANCES AT THE FORESTS OF EUROPE.

142. It appears that of the whole extent of the continent of Europe there is nearly 20 per cent occupied by woodlands. These woods have performed an important part in the making up of the British arboretum, as we find that a considerable number of the kinds of trees and shrubs introduced from time to time into this country has been supplied from different parts of Europe. Indeed, when we consider that Europe runs about 2400 miles north and south, and that it lies wholly within the north tem-

perate zone, and is therefore, in general, not subject to the extremes of heat and cold like the other great divisions of the earth, and in this respect corresponds very much to Great Britain, it is not surprising that specimens of nearly all, if not the whole, of the indigenous ligneous plants of Europe are now quite common in the British Isles.

143. The chief useful timber-trees indigenous to Europe are several species of the oak and of the firs and pines, together with the chestnut, ash, elm, lime, beech, and several others, all of which are to be found growing from the vine-productive regions of the south to the extreme and rigid north. In order, however, to have a passing glance at the woods of the different divisions of the continent of Europe, we shall devote a short paragraph to the forests of each of the countries composing it.

144. *France.*—The woodlands of France are said to embrace about 12 per cent of its whole area. From this country being so situated as to command the most temperate climate and some of the highest hills in Europe, it is said to contain the richest and most varied kinds of ligneous plants in any country embraced within the bounds of Europe. Much in regard to the woods and forests of France is similar in identity and analogy to those of Great Britain; and we believe that almost all of the timber-trees which are indigenous to the one are also indigenous to the other. The chief timber-trees, therefore, of this country may be said to be the oak, ash, elm, firs, and pines, with Lombardy poplar, sweet-chestnut, sycamore, alder, lime, beech, and on some parts magnificent birch. The French, like ourselves, have done much to forward the art of forestry in their country by the introduction of foreign trees; and consequently, fine specimens of trees from nearly all parts of the world are to be seen in the arboretums of France.

145. *Russia in Europe.*—This empire is said to have about 25 per cent of the whole area occupied by woods and forests. In the more northern parts we find the Scots pine, Norway spruce fir, common birch, alder, trembling poplar, willows of different kinds, maple, lime-tree, beech, elm, and oak, while the south abounds in the more rich productions of warmer climates. Many species of trees are to be found in Russia which are not indigenous to Britain. The introduction of foreign trees into this country has not been attended with very marked success, owing to the severity of the climate in winter. The forests, in some places, luxuriate in large unbroken tracts of country, quite undisturbed since they came from the hands of nature. No forestry on any definable plan has, so far as we are aware, as yet been established in Russia.

146. *Switzerland.*—The forests here are estimated at about

1,500,000 acres. The native or indigenous trees to this country are numerous, as in Switzerland we have the arctic climes upon its highest mountains and the warmer climates in the valleys. This country, in consequence, contains many kinds of native trees which are not indigenous to Britain. The more common and useful trees are, however, the elm, oak, birch, alder, olive, and various coniferæ, including the European larch, together with Lombardy poplar, sweet-chestnut, and sycamore. The introductions of foreign trees to this country have been varied and extensive.

147. *Norway and Sweden.*—These countries together have about a fourth part of their surface occupied by forests. The principal useful timber-trees indigenous to the country are the Norway spruce fir, Norway maple, Scots pine, elm, beech, ash, birch, lime, willow, and alder. An extensive trade is carried on betwixt these countries and Great Britain in the export of the timber of the spruce and pine. In the inland parts of the country, and especially in the north, there are immense tracts of unbroken forests of old timber. The most accessible parts are being rapidly cleared of the old timber, but young wood is growing up in its place. The attempts at the introduction of foreign trees suitable for temperate climates have attained considerable success here, and, in consequence, we now find oaks, poplars, foreign pines, walnuts, and others, growing to fair dimensions of timber in the plantations of the country.

148. *Spain and Portugal.*—The extent of land occupied by woods in these countries is estimated at about 6,000,000 acres. This is a very small proportion of woodlands for countries having such warm climates, and is, with the exception of Britain, the lowest of any division of Europe. The prominent timber-trees in the woods of these countries are the sessile-fruited oak, Turkey oak with its varieties, evergreen oak with numerous varieties, and the cork-tree oak, stone pine, and Scots pine, with Lombardy poplars, sweet-chestnut, sycamore, and birch. The silver fir is sometimes met with, as also the larch on the higher mountain-ranges of the north. This is a country well adapted for the introduction of exotic trees, and this branch of arboriculture has had the attention of the Spaniards since the days of communication with foreign countries began; consequently we are not surprised when it is stated that specimens of all the ligneous plants of the world have been seen growing successfully in one or other of the botanic gardens of Spain. The list of indigenous trees of this country is immense.

149. *The Netherlands.*—The woodlands here embrace an extent of about 500,000 acres. The natural timber productions of these parts of Europe are of small importance, although very fine specimens of several importations, especially from America, are numerous. The

catalogues of the botanic gardens of Leyden show that the introduction of foreign trees and shrubs occupied the attention of arboriculturists there as soon as those of any other country in Europe.

150. *Germany.*—About one-fourth of the whole extent of Germany is supposed to be occupied by woods and forests. The chief indigenous trees of this part are oak, larch, beech, firs, and pines, with chestnut, elm, lime, birch, ash, and poplar. It appears that the ligneous plants of Germany embrace those of Great Britain along with her own. The forests in some parts are of great extent, and very valuable, first-rate timber of the trees above mentioned being procured from them. The introduction of forest-trees has been varied and extensive, and very fine specimens of different foreign trees are now common in the country.

151. *Italy.*—The extent of woodland here may be set down at 5,000,000 acres. The more important timber-trees common in the woods are various species of the oak, poplar, pine, and fir, with walnut, plane-tree, and chestnut. The introduction of exotic trees and shrubs from all parts of the world has occupied the attention of the Italians since the fifteenth century, and consequently we now find fine specimens of some of these quite common in the south of Italy. The salubrity of the climate of this country is very well known, and the success of the introduction of foreign trees can thus be accounted for. Italy possesses, from introduction, nearly all of the ligneous trees of Australia, and, as in the case of Spain, it is considered that the ligneous plants of all the world might be cultivated with success here. In the south, from the calm and genial character of her climate, she is capable of growing the trees of tropical climes to perfection; while among the rugged and cold hills of the Apennines the hardy trees of arctic regions will luxuriate as in their native situations.

152. *Turkey and Greece.*—These countries are not of much importance as regards their tree and timber productions. The extent of land under wood in them may be assumed at about 10,000,000 acres. The trees most common about Constantinople are the Turkey oak, pinaster, stone pine, European nettle-tree, European judas-tree, evergreen cypress, the wild olive, carob-tree, European date-palm, turpentine-tree, the smilax-tree, the common ivy, the cherry-tree, the plane-tree. The Minorca box-tree grows in wild profusion on all the rocky surfaces of the country, and is largely exported to Great Britain for engraving purposes. We have no reliable authority to ascertain much about the introduction of exotic trees to these countries.

153. *Denmark.*—The forests of this country are estimated to extend to about 500,000 acres. The woods are made up chiefly of beech, white poplar, Scots pine, oak, and Norway spruce fir. A considerable number of exotic trees has been introduced into this

country, but these are found chiefly in the botanic gardens, and parks of landed proprietors.

154. *Belgium.*—In this portion of Europe the land under woods may be set down at about 1,000,000 acres. The indigenous trees of Belgium are comparatively few, owing to the similarity of the conditions of the soil and climate over all, and partly to the very limited extent of the country embraced.

SECTION XVI.—GLANCES AT THE FORESTS OF AMERICA.

155. These are the greatest and most productive forests in the world. Nature, in forming this vast continent, seems to have devoted her whole energies to the production on it of trees of the most useful and varied forms, and even to have produced some species which may well be termed the giants of creation. The great number of species of ligneous trees found in these forests is as wonderful as the extent of land they occupy and the size many of them attain; and here the species are not, generally speaking, found growing in exclusive masses, but nearly as regularly intermixed as if they had been planted by the hands of man. In North America nothing can be imagined more perfect in variety of colouring than the mixture of the dark pines with the lighter shades of the hardwoods; and this is particularly the case in the autumn months, when the deciduous kinds have their leaves changed from green to all the shades running between light yellow and dark crimson.

156. The extent of the American forests is still very great, notwithstanding that large portions of them have been cleared by man. We who live in Britain are accustomed to look on a plantation of 1000 acres as a large mass of wood; but when the mind is brought to contemplate a wood to which one of 1000 acres is comparatively only as a drop in the ocean, we are lost in wonderment, and our minds fail to grasp it. Yet such is the case, and made up, too, of the largest and finest timber yet known, stretching in dense unbroken masses for many hundreds of miles around every way.

157. The value, too, of these forests exceeds belief, even taking them at the lowest price; but we shall make no attempt at estimating them in this respect. America is still the grand timber-yard of supply for nearly the whole continent of Europe, and consequently enormous quantities of timber annually leave her shores for the eastern parts of the world. In glancing at the American forests, we shall take them up in the order of those of British North America, those of the United States and Mexico, and those of South America as a whole.

158. *Forests of British North America.*—Of all the divisions of America, this may be said to be the chief for the growth of valuable timber. When first discovered it was almost an unbroken forest of trees. Since then vast quantities of pine timber of very fine quality have been produced from it, as well as of oak, maple, and other kinds. The timber is felled and prepared for removal during the winter, and is floated down the rivers to Quebec in summer, where it is shipped to nearly all parts of the world.

159. The extent of land occupied by these forests is a subject involved in a considerable degree of uncertainty, from the want of accurate knowledge in regard to the extent of the whole of the field embraced; still, from the fact of this part of America being, excepting where cleared for settlement and occupied by rivers and lakes, almost wholly covered with trees, and from taking measurements of the whole country as at present laid down on our maps, an opinion may be safely ventured as to the probable extent of the great forests yet occupying the country. Making allowance, then, for cleared land, lakes, and rocky and barren parts, we should say that at the present time there are at least 500,000,000 acres of British North America occupied by a crop of timber.

160. Were these vast forests properly dealt with, they could not fail to be a source of great revenue to the country, and continue to produce annually, for an unlimited time, as much timber as they do now; but unfortunately we find that indiscriminate felling is going on everywhere, and in time this must lead to the exhaustion of the best timber, and render these yet valuable forests comparatively of little consequence.

161. The chief kinds of trees indigenous to this part of the American continent, and which make up the existing forests, are *Pinus strobus*, *P. resinosa*, *Abies nigra*, *A. alba*, *A. Canadensis*, *Thuja occidentalis*, *Larix Americana*, *Ulmus Americana*, with many species of oak, maple, and ash, together with several species of birch, poplar, and willow; while there are also the lime, beech, butternut, hickory, hornbeam, alder, &c. &c. Some of these, and the *Pinus strobus* in particular, attain large dimensions of timber.

162. In the far west of British North America—that is, in British Columbia—there are large forests of *Pinus strobus* and other coniferæ, including the Douglas fir, *Abies Douglasii.* There, in many instances, the latter tree attains a height of fully 300 feet, with a diameter at bottom of stem of about 10 feet.

163. *The Forests of the United States and Mexico.*—The northeastern portion of the United States, when first discovered, was covered by dense forests similar to those now occupying British North America. This part is now, to a large extent, cleared and under the

plough, so that no forests of any very great extent are in existence there. In the western States, however, there are still great forests luxuriating in a state of undisturbed nature. Large supplies of pine and other timber are still had from these forests, but chiefly for home use; and little or no export trade in timber is carried on by the United States.

164. From the detached character of the forests of the western States, it is impossible to form anything like a reliable estimate of their extent; still, we believe we may safely assume that there are at least 360,000,000 acres occupied by woods in the United States in all.

165. In the northern and north-eastern States the kinds of trees found growing are the same as those named in respect to British North America, together with fine specimens of the tulip-tree and *Platanus occidentalis*, sweet-chestnut, &c. &c.; while in the southern States there is a large proportion of the trees of the north, together with pines and many others suitable to the warmer climate there.

166. In the western States there are many kinds of pines and other trees found not indigenous to the eastern. In the State of California there are found growing some of the largest and most magnificent trees in the world, especially the one called *Sequoia gigantea*, which is now too well known to call for further remark. It may be also noted here, that from the State of California we have received a large assortment of the newer coniferæ now cultivated in Britain.

167. As a whole, the forests of the United States present many peculiar features of interest to the arboriculturist, as they have supplied Great Britain with perhaps the greatest number of accessions to her arboretum of any country in the world.

168. Some of the most extensive nurserymen in New York and Philadelphia appear, by their catalogues, to have the greater part of the trees and shrubs of Europe in their grounds; and the introduction of exotic trees into America began, we believe, as early as the first settlement of the country, and has been since continued from the never-ending desire of the people to possess something new.

169. From the much-felt want of trees in some of the western States where prairies exist, planting on a very extensive scale has been going on in many parts for some years past, and nurseries of large extent are quite common in the States. These send out annually an amount of plants and trees which in this small country would be considered fabulous.

170. *The Forests of Mexico* are, we believe, also of large extent, but we have no reliable authority to enable us to form a correct estimate of them. Here there are magnificent specimens of many of what we call the newer coniferæ found on the mountain districts, of

which we have now a number introduced into Britain—for example, *Pinus Devoniani, P. Russelliana, P. macrophylla, Picea religiosa, Cupressus thurifera*, &c. &c.

171. *The Forests of South America.*—In the north of this portion of America there are the plains bearing only occasional groups of trees; and in the middle or tropical parts of it, there is the great basin of the Amazon, called the *Silvas*, this being exclusively occupied by forest-trees; while in the south there are the Pampas, these being treeless plains extending for more than 2000 miles, with an average breadth of some 500 miles.

172. From the last paragraph it is to be inferred that a great part of South America is made up of plains destitute of trees, and that therefore it does not contain so much woodland in proportion to its surface as North America does. In the basin of the Amazon, however, there are nearly 400,000 of square miles of the country under a thick crop of wood, interpenetrated by innumerable creeping and trailing plants. The character of the forests here is something very wonderful—grand, gigantic specimens of trees of many different kinds mingle together: large trees displaying the most brilliant colours in their flowers; others having golden clusters of different colours hanging from their branches.

173. In the warmer or tropical parts the chief kinds of trees are palms, in great variety—breadfruit-tree, wild-figs, logwood, mahogany, brasilwood, cassias, bignonias, and melastoms; while in the more temperate regions a large proportion of the trees consist of araucaria, pines, abies, and other coniferæ.

SECTION XVII.—GLANCES AT THE FORESTS OF ASIA.

174. Asia surpasses all the other great divisions of the earth both in the greatness of its mass and the grandeur of its features. Comparatively little is known as yet in respect to its forests, however, especially of those lying in the more interior parts, and even the information we possess as to those lying along its boundaries and coast-line is but vague and unreliable. We are aware, however, that forests of great grandeur and vast extent do exist over a great part of this quarter of the globe; but to give anything like a reliable estimate of their extent is at the present time impossible.

175. In the southern parts of Siberia we are informed that dense forests of very fine timber exist, consisting principally of larch, Siberian pine (*Pinus cembra*), Scots pine, poplar, birch, oak, lime, juniper, and willows. It is said that here the *Pinus cembra* attains a great height, and large dimensions of timber.

176. The only part of Asia of which we have, at the present time, decided information in regard to its forests, is India, where an improved general system of forest administration is now being carried out under the Government.

177. A few of the principal trees indigenous to India are the *Pinus longifolia*, Himalayan box, sal, teak, ebony, deodar; of the latter there are large forests composed entirely of it. There are also sandal-wood, ironwood, Himalaya fir, and various others. It may be remarked that on the Himalaya Mountains there are large forests of the *Cedrus deodara*, oak, birch, beech, and chestnut.

178. China and Japan seem to have forests of considerable extent and importance, and from both of these countries we have many different kinds of trees introduced into Britain, and are likely to have many more still, as they become better opened up to our commerce.

179. The interior of Asia doubtless contains large forests, of which we have at present no acquaintance; but as its many regions are opened up to our botanists, they will yield us numerous additions to our arboretums.

SECTION XVIII.—GLANCES AT THE FORESTS OF AFRICA.

180. Africa is a division of the earth of which we know very little, excepting those portions of it which lie along the seaboard; and therefore we are not prepared to speak in regard to the extent of its forests. From observations made by that famous traveller Dr Livingstone, however, in the account of his travels in South Africa, we are made aware that vast forests do exist in some parts. He says that in some places near the Cape there are mountains which are clothed with evergreen succulent trees, on which neither fire nor drought has any effect, and that the seaboard gorges are clad with gigantic timber. In another part of his work he speaks of seeing grand specimens of the "baobab," or monkey-bread tree, and of the "mopane" tree. One of the baobab-trees he saw measured 85 feet in circumference at 3 feet from the ground. The baobab-trees seem to be wonderful examples of vitality, inasmuch that when the natives strip them of their bark for domestic purposes, they do not die, as would be the case with most other trees, but live and throw out a new bark, which is done by granulation. It is said that this stripping of the bark is done frequently, and no external injury, not even a fire, can destroy the tree. Dr Livingstone says that in several cases he saw trees of this kind cut down, and that even after they were separated from the stump, they continued to grow in length.

181. In middle Africa the oil-palm, the arachis or earth-nut, gum

acacias, cotton-trees, and the shea-butter tree, grow in abundance; and in the north we find the orange and the olive, with date and other palms.

182. From the geographical nature of Africa, comprehending as it does both tropical and temperate climes, there must be many different species of trees indigenous to it, especially in the central parts, of which we know nothing at present. Up to the present time, the number of species we have received from Africa is comparatively few; but when it shall have been thoroughly explored and opened up to science, we hope to have many additions to our arboretums from its forests.

183. Nurseries have been established in Africa—both by the Pacha of Egypt, and the French in their province of Algeria—for the purpose of acclimatising plants and trees introduced from other countries. And we may state also that Botanical Gardens have been established in the Cape Colony for the same purpose.

184. Those who wish to have full information in respect to the forests of the Cape Colony, will find it in the reports on the subject by Dr J. C. Brown, who was botanist there for some time, and is now resident at Haddington, in East Lothian.

SECTION XIX.—GLANCES AT THE FORESTS OF AUSTRALIA AND NEW ZEALAND.

185. The forests of Australia, exclusive of those of the province of Queensland, of which we have had no return, extend in all to about 160,000,000 acres.

186. In general the trees of this part of the world do not possess many points of utility to recommend them as good timber, although, at the same time, it must be admitted that several valuable trees are to be found here. In Australia most of the plants are of a character peculiar to itself, among which we may mention the leafless *Casuarina*, with its strangely jointed, drooping branches, and the *Eucalypti*, which form the gum-trees of the country. In the west there are acacias and proteas, while in the eastern parts the characteristic indigenous trees are the fern-tree, the grass-tree, and the yellow-wood, the latter a kind of mahogany.

187. Many kinds of trees have been introduced into Europe from Australia, and in the same way many of the European trees have been carried to Australia.

188. The forests of Tasmania extend in all to about 8,000,000 acres, and in this country there are trees of gigantic dimensions of the *Eucalyptus globulus*. Some of these have been found to measure 45 feet in circumference and 300 feet high. Here also the

Eucalyptus resinifera is found, in some instances, fully 200 feet in height.

189. In New Zealand there are about 12,000,000 acres occupied by forests, and here there are trees growing to large dimensions, and forming a supply of useful timber to the colonists. The *Podocarpus* is a useful tree in this country—what the colonists call yellow pine. It grows to a large bulk of timber, and is considered the best wood for furniture purposes, being light and durable.

SECTION XX.—CONDITION OF FORESTS AND PLANTATIONS AS GENERALLY EXISTING IN EUROPE, NORTH AMERICA, SOUTH AFRICA, AND AUSTRALIA.

190. Looking at the condition of forests and plantations as these are found existing in Europe at the present day, we must admit that it is, to a large extent, unsatisfactory, there being only a part of the whole, as yet, taken up for systematic improvement; and from this neglect the crops are, to a large extent, inferior, compared with what they would have been had they been attended to, and systematically thinned of the inferior portion of the trees constituting them.

191. There are extensive tracts of forest in Europe which still lie in a state of nature, the stronger and healthier portion of the trees overtopping and smothering the weaker; while large portions of the land occupied are wet, and the trees on them sickly and unpromising.

192. In making this general and broad statement in regard to a large portion of European forests, we have no desire to point out the want of proper and systematic management in respect to forests in any particular division of the continent; but we do think it incumbent on us, in a work of this kind, to point out in a general way what constitutes sound tree-culture, and wherein it is skilfully or unskilfully dealt with. The proprietors of forests in such a condition as we have referred to would find it vastly to their advantage, in respect to the value of their estates, were they to dry all wet portions of their woodlands by a proper system of drainage, and to thin out all inferior trees where the crops are crowded, and all in such a way as to leave the healthiest of the subjects standing clear of each other, but no more.

193. The greatest error in dealing with woods and plantations in Europe at the present day is, that the trees constituting them are, to a large extent, kept in a crowded condition. This state of things is observable in respect to woodland crops over a large part of Europe;

and, in consequence, a large proportion of them is found of a drawn-up character, and the trees forming them too tall in proportion to their diameter of stems at the various stages of growth.

194. All classes of trees, whether coniferous or deciduous, require a certain space of soil and air, according to their age, in which to develop themselves well; and if, at any stage, they are stinted of these, their healthy growth is arrested in proportion to the extent of want they sustain. Thinning, therefore, should be attended to systematically in respect to all plantations in all parts of Europe alike, as without this the crops will not become nearly so valuable as they are capable of doing where thinning is judiciously attended to.

195. In making the foregoing remarks on the condition of the forests and plantations of Europe, we do not mean it to be inferred that all the woodland crops in the different countries embraced are in the unsatisfactory state described, as there are many exceptions, where the woods and plantations are now well and skilfully attended to in the way of thinning, &c. &c. What we mean to deduce is simply, that a large part of the forests and plantations in Europe are in the crowded and unsatisfactory condition stated, and that therefore, where this condition is found to exist, it should be remedied without delay, and a more skilful and profitable mode of management in respect to plantations introduced, so as to bring about as soon as possible a greater degree of profit in this branch of rural economy.

Condition of Forests and Plantations as generally existing in North America.

196. In a young country like North America it is not to be expected that forests and plantations should be found in such a high state of cultivation as they are in the older States of Europe. In the former case the inhabitants have had to clear vast tracts of natural forest in order to make the land available for raising cereal crops for food, and therefore they have not been under the necessity of devoting their attention to the rearing of tree-crops, till recently they have found their supply of natural trees becoming insufficient for their demands; while in the latter case, the natural crops of trees have all been consumed, and therefore the inhabitants have for ages past had their minds directed to the rearing of trees to supply them with the timber they stand in need of for their many private and public wants.

197. For a considerable number of years past, however, large plantations have been made in most parts of North America, and more particularly in the Western States of the Union, where comparatively few trees have existed of natural growth, and where, therefore, the

settlers are compelled to plant, in order to both rear a supply of wood for domestic purposes, and to shelter their agricultural crops from storms that prevail in those formerly treeless regions.

198. The forests of natural growth in North America, although still of vast extent, are being rapidly cleared for the settlement and wants of the inhabitants; so much so, that the respective Governments are now meditating an extensive conservation of them in order to secure the keeping up of a supply of useful timber till plantations shall have been reared of sufficient extent and age to ensure a supply being had after the timber of the existing natural forests shall have been exhausted.

199. The existing forests of natural growth in North America are nearly all in a patchy and uncared-for condition, from the fact that only recently the legislatures have paid any attention to them, and that previously—and indeed in most cases even still—the settlers cut down the best and most valuable of the trees wherever they had need of them, leaving only the inferior and least valuable portions as the existing crops. This may be said to be the condition of the natural crops wherever the settlers have had access to them. Still, the forests which lie beyond the reach of the settlers—and there is still a vast extent of them so—contain a large amount of fine timber; but all of them are in a state of nature, no skill of man having as yet ever been brought to bear on them.

200. The older class of the plantations of North America are, generally speaking, in a condition similar to many found in Europe—that is, a great part of them has been allowed to grow up without attention to systematic thinning, and in consequence of this neglect, the trees are generally of a drawn-up character. Here trees of all kinds grow with a remarkable rapidity, and in a few years from the time of planting attain considerable size, and become useful to the settlers for many purposes. The settlers do, of course, thin their plantations in their own way; inasmuch as when they want trees for any purpose, they fell them, and remove them from the crops, but only in so far as they are wanted at the time. No systematic course of thinning is applied, and therefore, as already hinted, the crops are for the most part crowded, and on parts patchy and thin from the removal of trees which had been wanted for use on the farms. The foregoing remarks in respect to plantations are applicable to those as found in the United States.

201. In Canada very few plantations have as yet been made, but where these do exist, they are found in a condition in most respects similar to those of the United States.

202. Fence-row trees are much cultivated in both the United

States and Canada, and these are generally well managed, good specimens of various useful kinds being found along the fences, adding much to the shelter of the farms, and to the ornamental features of the country.

Condition of Forests and Plantations as generally existing in Cape Colony of South Africa.

203. There are extensive forests in South Africa, a considerable portion of which has been taken into the hands of the Government for conservation and improvement. The greater part of these forests are, however, in a crowded and neglected condition, comparatively little having as yet been done for their improvement, in the way of thinning out the weaker trees for the better development of the more promising ones, while the planting of the unoccupied portions of land embraced has been also but little attended to.

204. The forests of South Africa could, under a proper forest administration, be made a valuable source of income to the Government of that colony; but at present they may be said to be much neglected, and, on the average, costing more for their conservation than they yield. It is therefore to be regretted that these forests are not more carefully dealt with; and we have to recommend that they should be put under an improved forest economy, whereby the inferior portions of the respective crops could be judiciously removed and profitably disposed of, in order to admit of the greater development of the better class of trees, which should be allowed to stand in order to become of more value.

205. And not only should the existing forest crops be attended to as stated, but extensive planting should be undertaken also, in order to secure a supply of timber for the wants of the country after that of the existing forests shall have been all used up.

206. A considerable extent of plantations has been made in South Africa, and particularly on that part of the country stretching along the base of Table Mountain. But besides these, many farmers here have planted on their land, both for a supply of timber and for shelter to the land and live stock. Indeed, plantations are every year being made to some extent by the farmers of the country, so that on some parts it has now quite a clothed aspect. Nearly all of these plantations, however, are allowed to grow up in a state of crowdedness; and the result is, that the crops are generally of a drawn-up character, and much in want of thinning, nothing in this way having been attended to, excepting the removal of a few trees from time to time to supply the wants of the farmers for domestic purposes.

Condition of Forests and Plantations as generally existing in Australia.

207. The forests of Australia, although of a somewhat patchy character, are notwithstanding extensive as a whole, and consist chiefly of Eucalyptus and acacia. These forests, and especially those of the provinces of Victoria and South Australia, are being rapidly improved by their Governments, under the able superintendence of officers appointed to carry out in each case a thorough and well-defined system of forest economy. Here the crops in the natural forests are being conserved to a large extent, and systematically thinned of the weaker portion of the trees constituting them, all in such a way as to secure the better development of the healthy and promising portion; while the unoccupied portions of the land embraced are being planted with not only the best kinds of native trees, but also with many species from foreign countries known to be suitable to grow to good timber in the climate.

208. Perhaps there is no Government in the world at the present time which takes so much interest in the welfare of its forests and plantations as that of South Australia, as here 240,000 acres of the natural forests are being taken in hand for improvement in the way of thinning and planting, while all is being done in such a systematic way, that a satisfactory result cannot fail to be brought about in due time.

209. The plantations of these provinces are as yet young, few of them being of so long standing as to require much attention to thinning; but there is every reason to believe that in due time, as the crops need attention in this respect, they will be dealt with in a proper and intelligent way, and not allowed to become crowded, to the deterioration of their value, as is too often the case in countries much older than these.

210. We have not had returns from the other provinces of Australia in respect to the condition of their forests and plantations, but we are led to understand that in all of them forest administration is now being put into practice by their respective Governments; and from this we are warranted to state that in due time this great continent will have its at present barren wastes made fertile plains, and its now dry climate made more moist, all from the beneficial effects of its woodlands.

CHAPTER II.

SECTION I.—FORESTRY AS AT PRESENT UNDERSTOOD AND PRACTISED IN GREAT BRITAIN.

211. Forestry being an art still in its infancy, and one, from the nature of its crop, requiring a considerable number of years to test the results of any experiments that may be made in it, is not so readily defined in all its branches as farming is. The subject is a long and a broad one, requiring an age of observations and experience in any one to understand the effects of certain modes of operations on certain of its branches; and it is chiefly to this cause that the very slow progress that has been hitherto made in improving tree-culture is to be attributed. This every sensible and experienced man will readily admit, as he is well aware that the results of cropping land with trees require at least fifty years to ascertain. Having thus premised, we shall give an abstract outline of the chief heads of forestry as at present practised on the greater portion of the wooded estates of this country: afterwards we shall add some comparative remarks on each of the branches.

212. Practical forestry, then, as at present generally put in operation, may be summed up under these *nine* heads: First, the rearing of the young trees in the nursery-ground previous to their being planted in their permanent sites; Second, fencing the lands to be planted, in order to separate them from the agricultural portions of the estate, and to prevent cattle from getting into the plantations; Third, drainage of wet portions of the land purposed to be planted; Fourth, the distribution and planting of the young trees intended as a crop; Fifth, pruning of such trees as seem of a branchy and rough habit of growth; Sixth, thinning for the promotion of the growth of the better portion of the respective crops; Seventh, the stripping of bark from such of the trees as have it suitable for tanning purposes; Eighth, the clearing of a matured crop of trees, and its disposal; and, Ninth, the manufacture of timber.

213. With regard to the mode of rearing young trees in the nur-

sery-ground, great improvements have been effected within the last twenty years. Previous to the latter date, the mode was to sow the seeds of the different sorts of trees very thickly in the beds, so as to raise as many plants as possible from a small piece of ground, and to allow the young plants to stand two years in the seed-beds before their removal to the nursery-lines. Now, however, the most intelligent tree-rearers agree that the young plants are much improved in health and strength by sowing thinly in the beds, and by removing them into the lines when one year old only. Besides this improvement, another has been effected by attention to a judicious system of rotation in cropping. This was not attended to by the older class of nurserymen, and the consequence was that their young plants became unhealthy from the same sorts being repeatedly grown on the same piece of ground, without any intervening crop.

214. As to fencing, the chief improvement that has been effected within our remembrance is that of the use of wire and iron straining-posts; and it is a very great improvement, inasmuch as it is not only more ornamental than any other description of fence, but also infinitely more valuable in its durability than the old mode of fencing with wood alone.

215. Drainage, in the proper sense of the term, and as applied to woodlands, may be said to be an improvement of our own day, as we can well remember when it was not only little applied, but, where it was so, it was done on such a shallow principle as to be quite inoperative. For drying wet parts of woodlands, simple cuts of some 12 inches deep were considered sufficient within our own remembrance. Now, however, experience has taught us that open cuts from 36 to 48 inches in depth are absolutely necessary. In this respect we of the present day are much in advance of foresters of the old school, as, from the better application of drainage, we can now grow crops of good timber on land which they thought quite unfit for the purpose.

216. In the branch of distributing the young trees in a plantation, much experience has been gained within the last twenty years, and from this important experience we are now enabled to grow certain kinds of trees on certain descriptions of land, which formerly were considered unfit for planting, with any hope of success, with any sort of tree. The science of chemistry has given us much insight on this branch of forestry, as from it we can now understand the nature of the soil and its component parts; and from knowing somewhat of the food necessary for each sort of tree we plant, we can generally adapt the one to the other.

217. Pruning, generally speaking, was of all the branches of tree-culture the least understood by the older class of foresters. Forty

years ago, the system practised was chiefly that of lopping off all large branches from the stems, without respect to age, size, or kind, leaving the subjects standing like so many May-poles. The science of vegetable physiology has, however, taught us differently, and we now prune very sparingly, well knowing that the removal of large branches from trees deprives them, according to the extent of the operation, of the organs with which nature has provided them for the assimilation of the food they take in by their roots. In this branch of forestry, therefore, we have made important discoveries and improvements of late, and this from our better knowledge of the laws which regulate the healthy growth and development of trees.

218. Thinning plantations for the promotion of the growth of the best of the trees is a branch of forestry still but imperfectly understood. This is proved from the generally crowded and unsatisfactory state in which we find plantations in many parts of the country. The old mode of allowing trees in a plantation to stand so long unthinned as to become crowded, and thereby exhaust the soil, weaken their roots, and deprive their stems of branches, is still tolerated to a considerable extent, although nothing is more destructive to their healthy development.

219. This is certainly a singular fact in the history of the arboriculture of this country; more especially when we consider and take into account the great improvements that have been attained in the other branches of rural economy. Notwithstanding the generally high intelligence of our landed proprietors, and that they are far-sighted enough in the improvement of the agricultural portions of their estates, it cannot be denied that many of them are generally short-sighted in respect to this branch of their estate management, although by a proper attention to it, and understanding of it, they might be gainers to an incalculable extent. We are glad to say, however, that within the last twenty years the greater number of proprietors in England and Scotland, and in Ireland as well, have adopted a mode of thinning, on a regular and systematic principle, by which the crops are kept, at all stages of their growth, in a regular state, one tree from another, and from this at all times in an equally healthy condition, and are never allowed to become crowded before thinning, as used to be the case on most estates.

220. The stripping of the bark from oak and other sorts of trees for the purpose of tanning is an important branch of forestry in many parts of the country, and especially in those parts where oak is the chief woodland crop. On this branch but little improvement has been effected within our remembrance, although there is reason to believe that a better mode of drying the material might be adopted than that at present in use—in the open air, and unprotected.

221. The clearing of a crop of matured trees, its disposal and manufacture, is now, from the use of machinery by steam-power, a comparatively easy process compared with what it was previously, when only horse and manual power could be applied. We shall treat this subject at length in another part of the work; at present we only refer to it for the purpose of stating that on these branches of forestry very considerable improvements have been effected of late.

SECTION II.—FORESTRY AS AT PRESENT UNDERSTOOD AND PRACTISED ON CONTINENTAL EUROPE.

222. In Germany, Austria, and France—and particularly in the first-named country—forestry is well understood, and is put into practice in a well-defined and systematic way; the Governments of these countries taking the lead in respect to forest management, and carrying out efficient schemes of forest economy, both for the welfare of their communities, and as examples to the landed proprietors in these countries for the management of their woodlands.

223. A large portion of the woodlands of these countries is occupied by coppice growths, which are used largely as fuel, and for many other economic purposes; while extensive forests, and smaller plantations of timber, exist of all the kinds of trees indigenous to the Continent.

224. Nearly all the proprietors of woods in these countries manage their crops in a sectional way; that is, if the crops on an estate are found to come to maturity at, say, fifty years of age, then they are divided into fifty equal or equivalent portions, and one portion (the most matured) is cut each year, so that there may be had a constant supply of timber; the crop of the division cut the first year being again ready for disposal in the fifty-first year after, and in the same way all the other divisions follow for disposal in their order. If the crops on any part are found to require eighty or a hundred years to come to full value, then they are divided accordingly, and the oldest portion cut each year successively, so that a continual annual supply of wood is kept up on any property, without the crops on it being lessened either in extent or value.

225. The statement made in the last paragraph refers to the general mode of dealing with timber plantations on the continent of Europe, and we may here remark that, in regard to coppice woods, they are dealt with in a similar way, but are cut down at shorter intervals, say, from fifteen to twenty-five years, according to the object in view in rearing them. If the coppice growths can be profitably disposed of when of twenty years' growth, then the whole of this sort

of woodland crop is divided into, as nearly as possible, twenty equal or equivalent portions, and one portion is cut and disposed of each year, taking each portion in its order as to age; and in this way a continual supply of this class of crop is kept up on any estate.

226. The replanting of the land of each portion after it has been cleared of its crop is skilfully attended to in the forest economy of the countries under notice, the persons in charge being well trained to adapt the kinds of trees to the soil and site of each portion; and in this respect we find them show in their practice an extensive knowledge of the natural habits and peculiarities of the trees they cultivate.

227. In renewing the crops on the cleared portions of land, as these come to be dealt with each year, advantage is taken of the spontaneous growths, or young seedling trees, that have come up on them; and, if considered judicious, seeds of the different kinds of trees it is wished to rear on them are sown on unoccupied spots; and planting with young trees is undertaken only on such parts of the land as may be found unsuitable for the renewal of the crop by sowing the seeds.

228. As the young crops make progress, thinning is attended to; but in this branch of arboriculture we are of opinion that the French, Austrians, and Germans are defective—as, generally speaking, their crops are kept in what may be termed a crowded condition, whereby the trees are grown too tall in proportion to their diameter of stem; and thus their respective crops are prevented becoming so valuable as they are capable of doing were they more liberally thinned.

229. In most of the other countries of Europe, systematic forestry has not generally been so well attended to as in the countries referred to. We observe, however, that in most of the other divisions of the continent of Europe the German mode of forestry is being put into practice, and is fast gaining ground upon the old haphazard way of clearing here and planting there as has prevailed hitherto, vastly to the disadvantage of the landholders themselves, as well as to the States of which they are a part.

230. We may here refer to the State of Portugal as one likely ere long to take a leading part in the arboriculture of the continent of Europe; and we mention this, as we are aware that the present Chief Commissioner of Woods and Forests for that country is planting, experimentally, all the kinds of newer coniferæ, with a view to ascertain their suitableness for becoming useful timber in Portugal. We think it right to record this fact, as indicating a commendable spirit of improvement in the right direction, for the future welfare of Portugal as a nation.

SECTION III.—FORESTRY AS AT PRESENT UNDERSTOOD AND PRACTISED IN THE UNITED STATES OF NORTH AMERICA.

231. Forest science, in the United States of America, may be said to be as yet only in a state of infancy,—by far the greater part of the people here being destroyers of wood, while only the few are planters of trees. Of late years, however, the Agricultural Departments of these States have paid great attention to the matter of forestry, and are at present devising a scheme for conserving existing woods and planting new forests; and therefore in due time we may reasonably expect that the work of planting new lands, and replanting old woodlands, will be undertaken on a scale consistent with the wealth and resources of such a great country. The most intelligent part of the people of this great country are now aware of the evil incurred from the indiscriminate clearings that have been made of the original forests everywhere, and of the immense advantages that result from judicious planting; and they now seem to have made up their minds to enter on a new era in respect to the improvement of the land and climate by growing trees in a systematic way, wherever this may be found necessary, both for the advantage of the landholders individually, and for the country generally.

232. An important bill has lately been passed in Congress, and has become law, which provides that every future sale of Government land shall be with the condition that at least 10 per cent of the timbered land shall be kept perpetually as woodland; and if the land be not timbered, then the patent is to be issued on the condition that 10 per cent of the quantity is to be planted with forest trees within ten years, and to be kept for ever as woodland. This is a step in the right direction, and as the people of the United States do not transact their business by halves as many in older States do, but, when they have made up their minds, perform it thoroughly, we have every reason to conclude that in due time this vast country will become again well wooded.

233. Although forestry has been much neglected in the past here, still we are aware from our own observations, while travelling in the country, that extensive plantations have been, and are being, made by private landholders in all parts of the country—and especially in the Western and Prairie States, where they are an absolute necessity in order to protect the crops and stock of the settlers from storms that prevail there; and it is admitted by the inhabitants of those regions that they are vastly benefited by the presence of the plantations that have been made, although these are, compared with what is still to do in that way, of small extent.

234. The kinds of trees generally found growing in these plantations are platanus, sycamore, ash, elm, Scots pine, Weymouth, Austrian, and various other pines, together with European larch and spruce fir, intermixed with sugar maple, black walnut, hickory, black cherry, chestnut, oak of various species, locust-tree, poplar, Virginian willow, juniper, common arbor-vitæ, and many other species of both coniferous and deciduous trees.

235. Of the species named, preference is generally given to the sycamore, the Scots and Austrian pines, and to the European larch and Norway spruce fir, as being the most rapid in growth, and maintaining a healthy condition on most soils and sites.

236. In forming plantations in the United States, the land is generally prepared by a course of ploughing and harrowing; and this done, the seeds of the oak, walnut, hickory, chestnut, and some others are sown at once in their permanent sites, while the platanus, poplar, and willow are raised by cuttings inserted on the sites where they are to form permanent trees. Other sorts are transplanted on the land in the usual way.

237. The distances apart at which the trees are planted in American plantations vary very much, some planting them at 4 feet apart, and others at twice that distance. On the average, however, 6 feet may be stated as the distance apart of most of the young trees we have seen in young plantations in America; and as they grow very rapidly here, even at the distance of 6 feet apart, they ere long become crowded and in want of thinning. This operation, however, is not much attended to, as the proprietors, generally speaking, have little or no skill in the matter, and thin out only such trees as are wanted for use on their farms; and from this we find the crops nearly all in a crowded condition,—of course, less or more according as the plantations may be of short standing or otherwise.

238. Plantations might be formed in the United States within a very short period of time; as the young trees planted, as well as those from the seeds and cuttings intermixed with them, grow up very rapidly, and give a clothed aspect to the neighbourhoods in which they are found within even three or four years. All that is wanted in order to have North America made a well-wooded country, is for the Government—or the legislatures of the respective States—to conserve extensive portions of their existing forests, together with a large extent of their waste lands adjoining each reserve; and in these to improve the existing crops, and plant new plantations, all upon the most approved system of modern forest science, conducted by a staff of officers in all respects able to carry out such a scheme. This would be an example to all private landholders in rearing plantations on their respective properties; and would soon lead to a state of

things quite the reverse of what now obtains in regard to forest management as at present understood and practised in these States. There are some extensive nurseries in the States, in which are reared all the different kinds of trees used in planting.

SECTION IV.—FORESTRY AS AT PRESENT UNDERSTOOD AND PRACTISED IN CANADA.

239. As yet forestry is but little understood in Canada, and has been put into practice only on a small scale here and there. Here, however, as well as in the United States, the provincial governments, and especially the Government of Ontario, are, we have reason to believe, preparing themselves to enter on and carry out a scheme of forest economy worthy of the country and people. This is, in respect to Ontario, to conserve and improve large portions of the existing forests, in various parts of the province; to establish suitable nurseries for the rearing of young trees; and to make new plantations on all the cleared and unoccupied parts of the reserves.

240. No country in the world would be more benefited by extensive planting than Canada, as its long and cold winters would be very much ameliorated by them, while the great heat of its summers would be moderated from the same cause; and thus the agricultural interests of the country would become vastly improved, and every other branch of industry would be strengthened in proportion.

241. Plantations do exist here and there in Canada, but they are of small extent generally, and much neglected in the way of thinning. In short, no definite system of forestry has as yet been put into practice in Canada; but there is every prospect of this branch of rural economy being taken up and systematically attended to ere long.

242. Fence-row trees are well attended to in this country, however, and in many districts prove of great advantage to shelter the crops and live stock of farms.

SECTION V.—FORESTRY AS AT PRESENT UNDERSTOOD AND PRACTISED IN AUSTRALIA.

243. In adverting to forestry as understood and practised in Australia, we are to be understood as speaking in regard to the provinces of South Australia and Victoria only; as we are not sufficiently acquainted with the state of matters in regard to the forests of the other provinces embraced to enable us to refer to them with any

degree of certainty. In regard to the two provinces named, then, we have to state that forestry is being well conducted in them by their Governments, under boards of directors, with inspectors and conservators. Here the conservation of extensive tracts of the natural forests has been secured, and these are being improved by thinning and planting on a large scale.

244. The chief kinds of trees planted on these woodlands are—*Eucalyptus rostrata*, *E. corynocalyx*, *E. globulus*, *E. marginata*, *E. viminalis*, *Pinus insignis*, *P. halepensis*, *P. maritima*, *P. Canariensis*, *P. Jeffreyii*, *P. sylvestris*, *Quercus pedunculata*, *Fraxinus Americana* and *excelsior*, *Juglans regia*, *Casuarina*, *Castanea vesca*, *Abies Smithiana*, and several other *Abies*, with poplar, maple, and many other species, natives of both Europe and America.

245. All the young trees planted are distributed over the land, each sort on a soil and site adapted to its natural requirements, so that the whole are generally found to prosper well, and the greater part to make rapid progress. And it may be mentioned here that in distributing the young trees on the land they are planted at distances varying from 6 to 8 feet apart, according to soil, site, and natural habits of the subjects—that is, on poor soils and exposed sites they are planted at 6 feet apart, and on rich soils and sheltered sites they are put in at about 8 feet apart.

246. Nurseries have been established in several of the Government reserves, in which a supply of young trees is reared for the planting of the enclosures. In most cases, however, the oaks, chestnuts, and walnuts are reared by sowing the seeds of these on their permanent spots in the enclosures.

247. The foregoing remarks are of course applicable to forestry as it is being carried out by the Governments of these colonies. Planting by private parties has been attended to in a small way, however, and we are informed that many private landholders are now beginning to plant somewhat extensively, since they have seen the success of the Government operations; and from this it is reasonable to infer that this wise movement on the part of the respective Governments is destined to bring about ere long a great change for the better in regard to the improvement of the countries, both climatically and agriculturally.

248. As the Government plantations made in the provinces referred to are all under the directions of able men in forestry, there is no doubt that they will be systematically attended to in all respects as they grow up; and from this it is reasonable to conclude that private parties who plant will take example accordingly.

SECTION VI.—FORESTRY AS AT PRESENT UNDERSTOOD AND PRACTISED IN NEW ZEALAND.

249. The Government of New Zealand has very wisely offered a liberal *bonus* to all its landholders who will plant and maintain in good order a certain proportion of their subjects; what proportion this is we have not at present the means of ascertaining, but it indicates the wisdom of the legislature of that colony, in thus holding out encouragement to plant.

250. There are few countries in the world whose climate is better adapted to the growth of trees than that of New Zealand; and from this a great many of the settlers have planted somewhat extensively, not only the native sorts of trees, but also many species natives of Europe, America, Africa, and Australia, all of which are said to grow well here, and promise to become valuable to their proprietors. In regard to the plantations of this colony, we are informed that they are, generally speaking, well managed in the way of thinning; and that they already produce, in many cases, considerable revenues to those who have them, besides being of vast advantage in producing shelter to stock and crops in their respective neighbourhoods,—thus showing that forestry, in this far-off part of the world, is carefully attended to, so far as it goes.

251. We understand that the Government of New Zealand is taking active steps to preserve the native forests from further destruction; and that it is also planting on a large scale, as is being done in the sister colonies of Australia. That these plantations are well managed we have no doubt whatever, as the parties in charge of them are qualified to attend to their business in such a way as to secure good results. Several years must elapse, however, before we can judge fairly as to forestry in a new country like this, as much of what is being done is as yet experimental.

SECTION VII.—FORESTRY AS AT PRESENT UNDERSTOOD AND PRACTISED IN BRITISH INDIA.

252. The Government of British India has set a good example to other states of the world in its nursing care of its forests; and for this it is deserving of the highest commendation. The natural forests of British India are well known to be of very great extent: they occupy large portions of land on various sections of the country, and are said to contain very valuable timber of various kinds, and especially TEAK (*Tectona grandis*), SAL (*Shorea robusta*), CEDAR (*Cedrus*

deodara), SANDAL-WOOD (*Santalum album*), and INDIA-RUBBER TREE (*Ficus elastica*).

253. Of these forests the Government has reserved for improvement somewhere about 13,000,000 acres; and this is placed under an able staff of forest officers, who carry out improvements in respect to thinning and planting, &c.

254. Besides improving the condition of the natural forests here, planting has been, and is being, undertaken to a large extent; as for example, it is reported that over 3000 acres have been planted with sal, all in one forest, and over 100 acres have been planted with *Cedrus deodara*, horse-chestnut, and walnut, and that all are doing well.

255. With regard to teak, it is said that this tree is being planted on suitable soils to a very large extent; and that the *Ficus elastica*, or India-rubber tree, is also being cultivated to a large extent, and found very profitable.

256. In many parts here, plantations of the various kinds of trees cultivated were undertaken as experiments for the instruction of the subordinates of the forest department, and so as to ascertain the effects of soil and situation in the rearing of certain kinds; and from these very valuable experience has been gained for future guidance in conducting planting operations.

257. Besides native trees, many kinds introduced from foreign countries have been planted, and that to a considerable extent: for example, over 300 acres have been planted with the Australian tree known as *Sheaoak* (*Casuarina*), while various species of the Eucalyptus, also from Australia, have been planted, and are all doing well. Several species of acacia are also in cultivation, thus proving that the trees of Australia promise to become a valuable addition to the woods of India.

258. The rapidity of the growth of planted trees here is remarkable; as for instance, it is common for the young teak trees to attain the height of 20 feet in six years after they are planted, and the Eucalyptus makes even a greater growth than these in a given time.

259. The distances apart at which the trees have been planted in the young plantations in British India vary very much; the object in this respect having been to plant first at various distances apart, in order to ascertain the effects of certain distances, tree from tree, on the growth of certain kinds. We may remark on this head, however, that a good many of the young trees in the plantations have been planted at distances from 12 to 15 feet apart.

260. In connection with the reserved forests here, there are several nurseries established, for the purpose of rearing young trees for planting out into the enclosures.

261. In making plantations here, some kinds of the trees are transplanted from the nurseries, while other kinds are raised from seeds sown on the spots where they are to grow in the enclosures,—all as experience has proved the best mode of dealing with certain kinds.

262. The foregoing is a short outline of forestry as at present understood and practised in the Government forests of British India, so far as we have been able to understand this up to the present time. India embraces a wide field for forest operations, however, and there is no doubt that the parties who have the superintendence of improving the old and natural crops, and of making new plantations in the Government reserves, will at first have much to learn—much to do and to undo—before they can with perfect decision hold by a system of forest economy in all respects, and in all its details, adapted to the soils and climates embraced.

263. Private landholders have planted a good deal in India; but we are led to understand that the plantations of these are not, generally speaking, well managed, but are in a great measure left to nature. Still, it is to be inferred that the success already known to attend the plantations of the Government here will in due time influence the private landholders to improve their properties by similar attention to their woodlands; and thus an improved state of things in regard to woods will gradually come about all over the country—vastly to the advantage of every department of industry in this great country.

SECTION VIII.—FORESTRY AS AT PRESENT UNDERSTOOD AND PRACTISED IN CAPE COLONY OF SOUTH AFRICA.

264. In this colony systematic forestry seems to be but little understood; as although there are extensive forests of natural growth on many parts of it, and although a considerable extent of plantations has been, and is still being made on many parts, comparatively little attention seems to be paid to the improvement of either class of woodlands. See our remarks in paragraphs from 203 to 206 of this book.

SECTION IX.—THE CAPABILITIES OF FORESTERS, AS A BODY, TO CARRY OUT IMPROVEMENTS IN ARBORICULTURE.

265. We all know that a surgeon cannot practise successfully on the human subject unless he has been trained by a thorough acquaintance with the anatomy and constitution of man; we know

that a veterinarian cannot practise with any hope of success on the diseases of the horse unless he has studied the anatomy of that animal; and we are also aware that every man who means to be an intelligent and profitable farmer must learn the art, not only practically, but theoretically, in all its branches. If in such cases training to the end in view is so necessary to success, it follows that foresters should undergo a certain course of training before they can be safely and profitably intrusted with the rearing of plantations. Further, it is admitted as a general rule in all professions, that in this age of general improvement, whatever department a man shall take up as his particular business, he should, before entering into it, whether upon his own account or as agent for another, make himself acquainted with such branches of science as have a direct bearing on it, and are likely to qualify him for it, as, if he do not, he cannot possibly succeed creditably to himself or to his employer. Admitting these points—and their practical tendency cannot be disputed—it must be confessed that although foresters have made very considerable progress in their education of late years, still their general capabilities do not tally with the points stated. There are several of the sciences which have a direct bearing on the art of forestry; and without a knowledge of them it is all but impossible for a man to be an arboriculturist in the true sense of the term, or at least to such an extent as to enable him to carry out improvements in the art with profitable results; and from these considerations the conclusion follows, that of the men who are engaged in forestry, and have the management of woods, there are still comparatively few who have received such a training and education as is necessary to their being trustworthy and intelligent in all respects in the line of their business. As this is a highly important point both to foresters and proprietors, and one in which we are personally deeply interested—in fact, one to which we have devoted a large part of our attention to explain and illustrate during the last thirty years—we shall here take it up, somewhat fully, for the benefit of all concerned, more especially as on the proper qualification of foresters depends much of the future success in the art of arboriculture.

266. We are acquainted with a large number of foresters occupying trusts in all parts of the country; and although very considerable progress has been made by most of them in their education and general intelligence, still there is only a small proportion of them who may be said to be really qualified men, and capable of conducting their charge in a highly intelligent and really trustworthy manner. Many of them are mere workmen whose only qualification is that they can plant trees in the usual way, and cut them down with the axe when local circumstances require the operation; and the result

of this want of knowledge is, that the crops under their charge have not succeeded so well as they would have done had they been under the inspection and control of men in every respect learned and trained for the charge. This may by many be considered an overdrawn picture of the state of matters under notice, but we are prepared to prove that it is by no means so, but represents the simple truth of the case in regard to the general capabilities of the men who have the management of plantations in this country.

267. It would indeed seem inconsistent in the manager of an institution to appoint a man who had no skill in medicine and surgery to act as doctor to the patients of the institution; and yet this would only be a parallel case to many which we could name, as practised by landed proprietors in their appointment of men to the management of their woodlands. Many still seem to look upon trees as things that can take care of themselves, and that require no particular attention after they are put into the ground. Than this view of the matter, however, there can be nothing more erroneous, as, without skilful attention in many respects, trees can, after they are planted in a mass, no more grow up profitably as a crop of timber, than turnips can attain large bulk if not thinned.

268. It is indeed very singular that a proprietor should appoint an uneducated and unskilful man to the management of his woods, while he generally is more careful in his choice in regard to a man to take the management of his home-farm, although in the former appointment there is generally more at stake than in the latter. We have stated these views to several proprietors who have employed us to engage men for them to take the charge of their woods, and the only reason that we have received on the point was, that the services of a highly qualified man could not be obtained for such a small salary as the profits from their woods would admit of their paying. We grant that this may be quite true, but it is wrong in principle; and if true, it is the fault of the proprietors themselves that their woods do not pay them better than they do, as the more qualified the forester, the more likely are the profits from his woods to be remunerative to the proprietor.

269. The subject under consideration may be summed up thus: Foresters, generally speaking, are not possessed of sufficient education to give them capacity for carrying out improvements in arboriculture; and until we have a better educated class of men reared to the profession, a large portion of our woods must remain a comparatively unprofitable part of the resources of landed property. Many proprietors have not taken the right way to ensure their plantations being so highly profitable to them as they are capable of being made, as they have appointed unqualified men to their management, from a

mistaken notion that a few pounds saved on the forester's salary was economy, and a saving of expenditure; while the fact is, that from the want of skill he was yearly losing much more in the deterioration of the woods under his charge.

270. Were proprietors to look to their own interest, they would upon no account employ men to take charge of their woods who would do so at a low salary, as such men invariably want ability and skill to manage profitably; and, besides, they should never employ men who have not undergone proper training, and received an education fitting them for their charge. Were this attended to on the part of proprietors themselves, we should soon have a right class of men, and a class who would be able to advance the art of arboriculture to the standing its importance demands in the welfare of the country.

SECTION X.—EDUCATION NECESSARY FOR FORESTERS.

271. Having in the foregoing section shown that, although foresters have made very considerable progress in their education of late years, still, as a body, they are not capable of carrying out improvements in arboriculture, from their general want of education on the subject, we now come to state what, in our opinion, should be the amount of learning a man should possess in order to qualify him to act well his part in the business of forestry. He should be a good arithmetician, so as to enable him to enter into all sorts of calculations, and to keep correct accounts. He ought also to be a fair grammarian, and acquainted with the construction and composition of the English language, so as to fit him for keeping up correspondence with his employer, and describing his views on any subject in writing, when necessary. In order that he may be able to draw plans of plantations, and measure land and wood, he should be well versed in all the common branches of mathematics. These are the common branches of an English education, which every man ought to have. But, besides, he should be able to read French and German, so that, when a work is published on arboriculture in the one or the other of these languages, he may be able to read it for his own improvement in the line of his profession.

272. A forester should be able to know and describe plants and trees of any sort when he happens to see them, and when he may have occasion to write upon them. Without botany he cannot do this; he should therefore study this science, as, without it, it is impossible for him either to speak or to write intelligibly or correctly regarding the subject he cultivates.

273. Of all the sciences which are necessary for a forester, and

which bear upon his profession, there is perhaps none so important to his success as that of vegetable physiology, as without a perfect knowledge of this he is as unfit to take his standing as a first-rate arboriculturist as a surgeon would be to practise without anatomy. In short, with regard to this branch of a forester's education, no proprietor should engage a man to manage his woods who is not well acquainted with it in all its bearings on his everyday work.

274. As different sorts of trees grow better upon the land of one sort of rock than upon that of another, and as it is necessary that every forester should know the general peculiarities of the land of one district from that of another, he should have an acquaintance with geology, as without this he cannot possibly distinguish betwixt land adapted to grow larch and pine and that adapted to grow certain hard-wooded sorts of trees, and neither can he describe intelligently the precise local position of certain districts.

275. Chemistry is another branch of science which is as useful to the pursuits of the forester as it is to those of the farmer, without which neither the one nor the other can judge correctly as to the nature of soils. This, therefore, should form a part of the education of every man who would be an intelligent and first-rate forester.

276. Of late years it has been ascertained that not a few of the diseases of trees are attributable to the attacks of certain insects, the natures of which are as yet very imperfectly known or understood. In order to enable the forester, therefore, to investigate such matters, he should study and make himself acquainted with entomology.

277. With the amount of knowledge which has been described in the six immediately foregoing paragraphs, any man of intelligence may enter upon the management of woods, however extensive they may be, with every reasonable hope of success; but without such an amount of theoretical knowledge it is next to impossible that he can, —at least, in order to do justice to himself, to his employer, and to his country.

278. It must not, however, be understood that only the theoretical knowledge described is necessary to make a man a good forester, as without a course of practical training besides, he could not possibly be trusted with the management of woods. As well might we say that a student newly from college could practise medicine without any other preparation. What we mean is this, that besides a thorough training in all the practical parts of forestry, which can always be had on some first-rate estate where woods are acknowledged to be well kept and attended to, a knowledge of the sciences which have been described is absolutely necessary to make a man capable of thinking for himself, and to carry on improvements in arboriculture.

279. In recommending the study of these sciences to foresters, we

do not mean to say that they should be perfect professors of them all, but that they should be well acquainted with them, and to such an extent that they may be able to apply them to their business, in describing, suggesting, and carrying out certain modes of operations in order to gain certain ends. This they can always be able to accomplish from good books on the different subjects, as of such there are plenty nowadays, whereby an intelligent man may teach himself.

280. It may be considered by some that, with such an amount of education as is here inferred, a man might do better than be a forester. This may indeed at first sight seem correct, but it is not so in reality, as we do not know of any one possessed of such knowledge—theoretical and practical—who is not in a first-rate situation as a forester, and who is not well paid for his talents. We believe we do not overshoot the mark when we say, that any one having such an amount of knowledge will at once get into a first-rate situation as a forester, and at a salary equal to the income of most clergymen and country doctors of medicine; and besides, we think that we do not state too much in saying, that the very reason why there are so many foresters in situations at extremely low salaries is, that such are unlearned and unfit for better. Let as many as choose try the experiment of educating themselves as we have described, and we will warrant them getting into situations that will suit them. For we are well aware there is no proprietor of extensive woods who will not give a good salary to a good man, well knowing that the result is an improved state of things on his woodlands, in every respect.

281. We have sent out many foresters to situations within the last thirty years, at salaries varying from £70 to £300 per annum; and we here state that we have had great difficulty in getting men with practical ability combined with the necessary educational accomplishments. Proprietors are now too well aware of the value of a really good and intelligent forester not to employ him, although at a high salary.

SECTION XI.—SCHOOLS FOR THE THEORETICAL AND PRACTICAL EDUCATION OF FORESTERS.

282. It is humiliating to Great Britain that there is not in the country a school where young men can learn efficiently all the different branches of study in connection with forestry, theoretical and practical. This want has very frequently been brought prominently before us within the last twenty years, by young men who wish to improve themselves, and to excel in this department of rural economy, asking our advice as to where and how they could best learn it; and

the only advice we have been able to give was to put themselves under some practical forester of well-known abilities and large experience, where the woods under his charge were well managed and successfully grown. And we may here mention that within the last two years landed proprietors in India and the Colonies have applied to us, inquiring as to where their sons could be taught forestry, theoretical and practical, in order to fit them properly for the improvement of their estates in respect to forming plantations on them; and, from the non-existence of a school of forestry in Britain, we have, in all cases, had to recommend the parties to send their sons to German schools of forestry.

283. In advising young men, we have pointed out to them the great want there is in this country of schools for the education of those who wish to learn forestry in all its branches, theoretical and practical, while at the same time we have pointed out to them that in France there are good schools for the training of foresters, and also in Germany; but of course they were not inclined to go to the Continent to learn what they very properly thought they ought to be able to learn at home: and this leads us to repeat, what we have already stated,—it is very humbling to Britain that there is not in the country even one school where young men can learn efficiently all the branches of study in connection with forestry.

284. Then the question is, How is this want to be supplied, and proper schools for the theoretical and practical education of foresters established? Our answer to the question may be stated generally as follows: Let an ARBORICULTURAL ASSOCIATION be formed of some of the leading landed proprietors in the country, with a few men of science among them, having for their object the cultivation of trees on the most approved and improved principles of the age, and the training up of young men as foresters, according to these principles, in order to fill the places of the existing foresters of the old school, and thus, as early as possible, bring about an improved state of arboriculture for the general welfare of the country.

285. Then, supposing that such an association were formed, where and how is the field of their operations to be had? Of course they could not possibly undertake anything in a definite and practical way in respect to forestry without this. Such a field may easily be had, as there are many landed proprietors in this country who have more estates than one, and who would be willing, we have no doubt, to give over the woodlands on one of them for the purpose of forming an arboricultural school on it—of course, under safe and proper conditions to both parties.

286. If a field of this kind could not be had from a private landed proprietor, such a one could doubtless be obtained from the State, in

one or other of the Government forests. And surely it comes to be a matter of wise policy for the Government to give all liberal encouragement to such an association, and to lend its powerful influence to promote its views, when it shall be formed, not only by mere encouragement in words, but also by giving it an annual grant to support its efficiency.

287. The next point to consider is, how such an association should be conducted in order to render it, as far as possible, really efficient for the promotion of the interests of arboriculture. In the first place, a resident president would have to be appointed, as also a secretary, a treasurer, and auditor. Next, the working resident staff might be,—a forest manager, who would be accountable to the president for the proper working of the objects of the association. The president would be assisted by a professor of botany and vegetable physiology, and one of geology and chemistry, the latter combining physical geography and climatic science; while the forest manager would have also the assistance of a first-class practical forester, whose duties would be to carry out all the practical operations, under the directions of the manager, in dealing with the woods, and at the same time instruct and guide the pupils while at their various works in the woods. In short, the resident president would have the entire control of the theoretical education of the pupils, assisted in this by his professors; while the forest manager wonld have the full control of the forest operations.

288. To accommodate a staff of this kind, together with, say, one hundred pupils, a convenient house would require to be provided—and as to whether the pupils would be resident in it or not, would of course depend on a careful consideration of all the circumstances in connection with the locality in which the field was situated. At all events, one half of the pupils would require to attend at a given hour every morning, to hear lectures and other instructions on the subjects to be taught by the professors, while the other half would go out to work in the woods. These would return in the afternoon to get their course of instructions, while those who were studying in the morning would go out and take their places in the woods; and in this way the routine of daily theoretical and practical instructions would be carried on. Of course, a portion of the waste land would be taken up for planting every year, in order to have the young men trained to the proper way of doing it, as also thinning in the different plantations, with bark-stripping, pruning where necessary, draining, &c. In short, all these branches of work would be undertaken every year on some portion of the crops; and as all the works would be performed by the pupils themselves, under the direction of the forester, every one would have the full opportunity of gaining practical experience

as well as theoretical knowledge on the various branches of forestry. And it would be necessary to keep all the woods under the management of the association in the very best possible condition, so that their character might become a model for all others to imitate. And besides, it would be desirable for the manager and his professors to visit from time to time the woods on other properties, and take with them their pupils to see them, when they would have an opportunity of comparing the management of other woods with that of those on their home district; and in this way the pupils would get much useful information and experience, within the shortest possible time, under the guidance of their teachers, and thus render them more intelligent and experienced than they would be were their observations confined to the woods on the home field alone.

289. In dealing with the pupils, the amount of fees they would pay would of course depend upon whether they were lodged in the institution or not, and had bed and board provided for them. We should say that they should be resident in the institution, and all receive like treatment as to education, board, and lodging. If they were not resident lodgers, irregularity would be certain to ensue, and want of proper rule. Then, if lodged, £40 a-year might be a fair charge for each pupil. In accounting with the pupils, they ought to have put to their credit, and deducted from their fees, at the end of each term when settlement is made, the value of the work they perform in the woods, at a fixed rate per hour or per day, as may be arranged. This would make them more industrious than they would otherwise be, and make them take greater interest in the works they were engaged in. This value of work would of course be refunded to the association by their account against the proprietor of the woods for the works performed in them by their pupils.

290. In order that the pupils might be properly instructed in all the branches bearing on arboriculture, and to secure the professors and all concerned doing their duties, an examination of the progress made by the pupils should be made by the president and directors at the end of every six months, and awards put to the credit of the most proficient and deserving.

291. It is understood that all the pupils, previous to entering this institution, should be eighteen years of age and upwards, and have received a fair English education; so that when they enter it they may have to attend only to the branches bearing directly on the art of arboriculture, theoretical and practical. Then three years' residence in such an institution should be enough to enable any intelligent young man to become thoroughly acquainted with all the branches necessary to make him a proficient in forestry. Some, however, might require a longer time, all depending on the natural abil-

ities of the person. At all events, if a young man cannot learn sufficiently in four years, he ought not to follow the profession at all.

292. As the young men became proficient in all the branches, theoretical and practical, of forestry, and leave the institution, they should have each his certificate or diploma, stating his general acquirements and abilities, and whether he is *first*, *second*, or *third* class in his profession. These certificates should of course be given by the president and directors, and signed also by the professors; and they should form a guarantee to landed proprietors who might be in want of foresters that the holders are men of undoubted professional abilities, and worthy of being trusted with the management of their woods. What a contrast of character would this not make, as compared with the way matters stand in relation to foresters at the present time! The sooner such an association is formed, the better for all professing or having an interest in arboriculture. Till then, young men will have, as hitherto, to grope their way to arboriculture in comparative darkness; but once such an institution is established, it will be the beginning of light on the subject, which could not fail to increase to noonday in time.

SECTION XII.—A SHORT OUTLINE OF THE VITAL ACTIONS OF TREES, AND OF SOME OF THE PHYSIOLOGICAL PRINCIPLES DEDUCIBLE THEREFROM IN RESPECT TO FORESTRY.

293. A tree is an organised, living body, having its structure made up of cells, tubes, and membranes, and its vitality and growth maintained by absorption through its outer surface.

294. The body of a tree is formed out of a few earthy substances, together with water and air, and is fixed to the earth by its roots, and reared into the air in the form of a stem, bearing leaves, flowers, and fruit, but has no power of changing its original site.

295. A young tree is derived from seed produced by its parent tree.

296. The seed of a tree, when acted upon by certain stimulating agencies, begins to exhibit life; these agencies are water, heat, light, air, and food.

297. The seed of a tree, if placed in earth at a temperature not exceeding 32° Fahrenheit, will remain inactive till it decay; but if it is placed in earth moistened with water, some degrees above 32°, it gradually absorbs part of the moisture that surrounds it, and swells. Its tissue thus becomes softened, and stretches; the water is decomposed, and a part of its oxygen, combining with the carbon of the

seed, forms carbonic acid, which is thrown off. Food for the young plant is prepared by the starch being converted into sugar, and so the vital action of the embryo begins.

298. The embryo lengthens downwards into the earth by the radicle or young root, and upwards into the air by the cotyledons, the latter acquiring a green colour by the decomposition of the carbonic acid they absorb from the earth and air.

299. A certain degree of moisture in the soil is a necessary condition for maintaining the vitality and healthy development of all trees at all stages of their existence, as all organised bodies are made up of cells, tubes, and vessels, requiring a free circulation of the various juices throughout their structure.

300. The vitality of the seed being brought into action by the agencies of water, heat, light, and air, the young root lengthens at its point, and absorbs nourishment from the earth; this nutriment is conveyed to the summit of the plant by means of its cellular substance, and partly forced into the seed-leaves, now expanding, and there it is exposed to the action of light and air, and evaporated—but for the most part it is forced upwards upon the growing point.

301. The current of sap thus continues to be forced upwards from the root to the growing point, which lengthens, forming a small twig; and at the same time the first portion of woody matter is formed from the descending sap in the centre of the radicle. The growing point, as it receives the sap, aerates it and sends it downwards, forcing the root to form ramifications, while at the same time the gradual formation of woody matter takes place within the vessels of the young plant by the deposit of a peculiar secretion.

302. Before the growing point begins to lengthen, it acquires the rudimentary state of a leaf: this continues to develop as the growing point lengthens, until, when the first space between two leaves on the little twig ceases to lengthen, the first leaf has really attained its complete formation.

303. When the first leaf is fully developed, it carries on in a much more perfect manner the functions previously performed by the seed-leaves: it aerates the sap that it receives, and returns the superfluous portion of it downwards through the bark to the root, thus forming the first stratum of woody matter, a part of which is incorporated with the bark, the remainder forming wood.

304. While the growing point is ascending, its leaf forming and acting, and the woody matter created by it descending, the cellular tissue of the stem is forming and expanding horizontally to make room for the matter forced into it; so that development is going on simultaneously, both in a horizontal and perpendicular direction.

305. Simultaneously with the appearance of woody matter, the

emission of young roots, and their increase by addition to the cellular substance of their points, take place. They thus are made to bear something like a definite proportion to the leaves they are to support, and with which they must of necessity be in direct communication.

306. After the first leaf is produced by the growing point, others successively appear around it, all formed alike, connected with the stem in the same manner as the first, and performing in all respects the same functions as have been described in respect to it. At last the growing point or axis ceases to lengthen for the season; the old leaves gradually fall off; the new leaves, instead of expanding after their formation, retain their rudimentary state, harden, and fold over one another, so as to be a protection to the delicate point of growth—or, in other words, become the scales of a bud. We have now a shoot with a woody axis, and a distinct pith and bark, and of a more or less conical figure.

307. With the spring of the second year, and the return of warm weather, vegetation recommences. The uppermost, and perhaps some other buds, which were formed the previous year, gradually unfold, and draw up sap from the stock remaining in store about them; the place of the sap so removed is instantly supplied by that which is next it; an impulse is thus given to the fluids from the summit to the roots; fresh extension and fresh fibrils are given to the roots; new sap is absorbed from the earth, and sent upwards through the wood of last year; and the phenomenon called the flow of the sap is fully completed, to continue with greater or less velocity till the return of winter. The growing point lengthens upwards, forming leaves and buds in the same way as the parent shoot; a horizontal increase of the whole of the cellular system of the stem takes place, and each bud sends down organisable matter within the bark and above the wood of the shoot from which it sprung; thus forming, on the one hand, a new layer of wood, and on the other a fresh deposit of liber.

308. The sap which is drawn from the earth into circulation by the unfolding leaves is exposed, as in the previous year, to the effect of air and light; is then returned through the leaf-stalk to the stem, and sent downwards through the bark, to be from it either conveyed to the root, or distributed horizontally by the medullary rays to the centre of the stem. At the end of the year the same phenomena occur as took place the season before: wood is gradually deposited by slower degrees, whence the last portion is denser than the first, and gives rise to the appearance called the annual zones; the new shoot or shoots are prepared for winter, and are again elongated cones, and the original stem has acquired an increase in diameter

proportionate to the quantity of new shoots which it produced,—new shoots being to it now what young leaves were to it before.

309. The third year all that took place the year before is repeated, but on a more extensive scale. More roots appear, sap is again absorbed by the unfolding leaves, and its loss is made good by new fluids introduced by the roots and sent through the wood of the year before; new wood and bark are formed from matter sent downwards by the buds; cambium is exuded; the horizontal development of cellular tissue is repeated. Wood towards the end of the year is formed more slowly, and has a more compact character; and another ring appears, indicative of this year's increase.

310. In precisely the same manner as in the second and third years of its existence will the tree continue to vegetate till the period of its decay, each successive year being a repetition of the phenomena of that which preceded it.

311. The bark acts as a protection to the young and tender wood, guarding it from cold and external accidents. It is also the medium in which the proper juices of the plant, in their descent from the leaves, are finally elaborated and brought to the state which is peculiar to the species. Hence the character of timber is almost wholly dependent upon the influence of the bark. As the bark, when young, is green like the leaves, and as the latter are manifestly a mere lengthening out of the former, it is highly probable that the bark exercises an influence upon the fluids deposited in it wholly analogous to that exercised by the leaves. Hence it has been named, with much truth, the universal leaf of a vegetable. In fact, in many succulent plants there is no other part capable of performing the functions of leaves.

312. Leaves are at once organs of respiration, digestion, and nutrition. They elaborate the crude sap impelled into them from the stem, decomposing its water, adding to its carbon, and exposing the whole to the action of the air; and while they supply the necessary food to the young tissue that passes downwards from them and from the buds in the form of new matter for the formation of wood and bark, they also furnish nutriment to all the parts immediately above and beneath them. In proof of this, if a branch is deprived of leaves for a whole summer, it will either die or not increase in size perceptibly.

313. After the leaves have performed their functions they fall off. This happens at extremely unequal periods in different species. In some they all wither and fall off by the end of a single season; in others, as in the beech, they wither in the autumn, but do not fall off till the succeeding spring; and in a third class they neither wither nor fall off the first season, but retain their verdure during

the winter, and till long after the commencement of another year's growth: these are called evergreens.

314. The foregoing outline of some of the simpler facts in vegetable physiology in respect to the vital actions of trees, is taken chiefly from the works of that well-known author on the subject, *Lindley*. The facts stated should be firmly rooted in the mind of every forester, and acted upon by him in all the operations he performs, as there can be no doubt that a man's success in arboriculture depends upon his having a correct understanding of the nature of the vital actions described, and his being able to apply his knowledge of them to his daily operations, whether these may be the rearing of young trees in the seed-beds, planting them out in the woods, or thinning them preparatory to their becoming a crop of valuable timber. We do not here mean to infer that there are not good foresters at the present day who are almost entirely unacquainted with the science of vegetable physiology; still it must be evident to every one who has at all given careful attention to the subject, that unless the external influences by which plants are affected are clearly understood by a man, he cannot possibly have the power of conducting his operations at all times on sound principles, but must leave much to accidental circumstances.

315. We shall here endeavour to point out a few of the principles deducible from the physiological facts stated, as they are applicable to the everyday operations of the forester.

316. At the very commencement of their existence, and while in the seed-bed, young trees require to be attended to in respect to the agencies of water, heat, light, air, and food; and therefore the success of the forester, in his rearing of them, depends on the degree of intelligence with which he applies these agencies. In the first place, he drains the land thoroughly by underground ducts, in order to remove all stagnant water from its subsoil, and so increase its temperature; well knowing that underground climate is not less important to the healthy development of trees than that which is experienced above ground, and that it is only by perfect and skilful drainage that underground climate can be improved.

317. In the next place, he digs the land deeply on which to sow his seed-beds, separating its parts minutely, and making it as porous as possible, at the same time adding to it well-prepared manure; and all this he does from the knowledge that unless the land is cultivated deeply, he could not secure well-rooted plants—and that on securing them of this character, proportionally strong and healthy stems must follow as a natural result.

318. By these operations, then, the forester secures an increase of heat and food for the young plants he rears from seed on any piece

of ground; and after he has sown them he is careful to keep them perfectly clear from weeds, well knowing that the latter would rob the ground of the food he had put in it, and that they would also prevent the development of the plants he had sown, by their shading and keeping them from receiving the full advantages of light and air, were he to allow them to grow with them.

319. The advantages of light, heat, and food, although very decided and marked in the character of a crop of young trees properly dealt with while in the seed-bed, as compared with that of one reared under opposite circumstances, are, however, still more so in the case of the same kind of plants when they are planted out into well-prepared ground in the nursery, and compared with others of the same sort taken from the same bed, and of the same age, but planted on land not previously prepared for them. For example: We have planted out two-years' seedling larch on a piece of waste ground, which some few years previous had been under the plough, and at the end of the year they had not made shoots over five inches for the season; and over all they did not average more than fifteen inches in height. Now compare these with the following result. At the same time the larch referred to were planted, we had a portion taken from the same bed in which they grew, all of the same character in every respect, and planted them in well-prepared ground in our nursery; and the result was that at the end of the year they averaged upwards of thirty inches in height, all strong and robust plants in proportion to their height. Now, we would ask, what is the cause of this very great difference in the characters of these two portions of larch, seeing they were all taken from the same seed-bed, and of the same health and strength of constitution when planted out? It is this: The plants which were planted out on the old arable field had their roots excluded from the influence of the sun's rays by the thick turf and herbage growing on the surface, and consequently they were late in the season of commencing to grow; and even when their growth did set in it was but a weak effort, as the natural herbage became stronger and stronger as the season advanced, and almost entirely excluded warmth from their roots, which, in consequence, remained in a state of comparative inaction. On the other hand, the plants referred to as having been planted out on well-prepared ground in the nursery, had their roots placed under the most favourable circumstances in respect to the influence of heat. The season was a dry and a warm one, and as the ground is of a moderately rich character, light in texture, and porous, the sun's heat penetrated deep into it, and caused the plants to grow rapidly even in the early part of the summer, before those in the field had shown any tendency to push into growth. These

being the facts of the case, it is obvious that one of the first of a forester's cares should be to secure, as far as possible, the means of insuring a warm temperature to the soil in which he grows his trees; and this is to be obtained only by skilful drainage, and making the soil as deep and porous as he may have it in his power to accomplish.

320. From a consideration of the vital actions of trees it is clear that in transplanting them from the nursery to the open ground where they are to grow to timber, the younger they are at the time of removal the better will be their after-success; for the reason that a one-year's seedling plant can be removed with nearly all its roots entire and uninjured, while a plant of two years' standing in the nursery must be deprived of a considerable proportion of the most valuable of its roots in the act of removing it,—and more and more so at three years, or at four, and so on in proportion to the number of years it may have stood before transplanting takes place. This is a physiological fact too seldom acted upon by foresters, and in consequence we see in many parts of the country plantations of an unpromising character, where a healthier crop might have been, had the trees composing it been of a much younger age when they were planted.

321. As a rule, the younger a tree is the less check does its constitution receive by removal; while the older it is when removed, the greater is the damage its constitution receives, and the less chance there is of its recovering this and succeeding well afterwards.

322. The functions of respiration, perspiration, and assimilation, which are the particular offices of leaves, are absolutely necessary to the health of a tree, its healthiness being in proportion to the degree in which these functions are properly performed. Consequently, whatever tends to impede the free action of leaves tends also to diminish the healthiness of a tree. Sunlight is the principal agent for performing the vital functions of vegetation. Sunlight, when it strikes upon the leaf of a plant, either directly or indirectly, causes a decomposition of carbonic acid, an extrication of oxygen, and insensible perspiration: and this explains why there is generally more wood on the south side of a tree than on the north; and why depriving trees of their branches, and consequently of their leaves, is invariably attended by a diminution of the quantity of timber.

323. Then from these facts the forester must see how important a matter it is, in the training up of plantations, at all stages of their growth to thin them in such a way as to admit the full sunlight to every tree. Where this is not attended to the trees become weak and unhealthy, and ere long arrive at a premature old age.

324. Important as are the leaves of trees in their respiration, digestion, and nutrition, yet the fact is not unfrequently ignored by

the practice of some who have to deal with the rearing of woods. For example, only recently we had occasion to inspect the woods on a property where we found many trees, both hard-woods and conifers, had been lately pruned by sawing off large branches close to their stems,—some of the wounds being five and six inches across. Here the branches, with their leaves which had elaborated the crude sap as it was impelled into them, were barbarously removed, leaving all the vessels that connected them with the stems full of the crude sap and without the means of digesting it; thus inducing rapid decay in the fibre, which must ere long become rotten in consequence. Pruning, then, ought never to be practised without a thorough knowledge being possessed by the operator of all the laws which regulate the healthy action of the organs of vegetation. If well and intelligently gone about, pruning may be advantageously applied; but if unskilfully practised, as in the case here noted, it is highly injurious, and even destructive to the health and value of the subjects operated on.

325. We have given these few examples to show how necessary it is that foresters should become thoroughly acquainted with the laws that govern the healthy development of trees before they have the management of rearing them. We could give many more in illustration of the subject, but we think that what we have already stated is enough to impress upon the minds of young foresters the necessity there is for their studying to master all the branches of education referred to in the third section of this chapter, before they attempt to undertake the management of woods on their own account. For their rise or fall in the profession must depend on the amount of knowledge, theoretical and practical, they are able to apply and bring to bear on it; as, undoubtedly, those who do not attend to master the amount of education recommended must fall back into the ranks of the old school, and give place to those who have by their perseverance and industry attained to the desired knowledge on the subject, and are able to discriminate between the right way and the wrong in applying themselves to the different branches of their profession.

SECTION XIII. — THE RULES LAID DOWN FOR GUIDANCE IN THE PRACTICE OF FORESTRY IN ANY ONE COUNTRY MAY NOT, IN ALL RESPECTS, BE FOUND EQUALLY APPLICABLE TO THE PRACTICE OF FORESTRY IN ANOTHER COUNTRY.

326. Forestry, like agriculture, must be adapted to the peculiar condition of the country in which it is put into practice. A forester trained to his profession in Germany, where the climate is temperate,

and the crops reared all of classes of trees he had been accustomed to look upon as things well known and understood, would be very much puzzled were he at once put in charge of woodlands in the Southern States of North America. Here he would find kinds of trees different in most respects from those he had been accustomed to grow in his native land; and when he began to operate on the subjects, whether in regard to planting, thinning, or clearing, he would see that his former education in forestry could not, in all respects, be brought to bear successfully on the works he had taken in hand, and that he had still much to learn in order to adapt his former forest experience to suit the circumstances of the case.

327. The same thing may be said in respect to foresters trained in Britain, when they go to India, Africa, or Australia. In all these countries there is much that is peculiar to their respective climates, and which the European forester has to master ere he can properly deal with the necessary improvements in their woodlands respectively. From this it is evident that all foresters should be well educated in the respective branches of science that have a bearing on their profession; as, if not, they are certain to arrive at unsound conclusions when brought face to face with states of forest matters they had not previously been acquainted with, and which they have now to undo, and to bring into a new and more advantageous and improved condition.

CHAPTER III.

SECTION I.—WHAT PORTIONS OF A COUNTRY SHOULD BE PUT UNDER TREES, AND WHAT PORTIONS SHOULD NOT.

328. There are few districts of a country of any considerable extent that would not be much improved in their productive qualities by the presence of well-laid-out plantations, especially on high-lying parts with a naturally poor soil. On flat and low-lying plains, with a naturally rich soil, it is not necessary to plant to any considerable extent, as on such districts, from the climate being comparatively mild, and from the land being well adapted to agriculture, it is more profitable, both in a private and national point of view, to rear the cereal and other crops for food than to rear timber. Even in such districts, however, it is always found desirable to plant to a moderate extent, in order to sift the prevailing winds of the spring and early part of summer, which, without a judicious dispersion of trees, in the form of broad and well-defined belts, or of hedgerows, often do very great damage both to crops and young live-stock. Only moderate portions of the low-lying plain-lands of a country should therefore be put under trees, and the extent of these should in all cases be regulated by the character of the district.

329. On undulating and somewhat hilly parts of a country, as well as on elevated table-lands, a greater extent of plantations is necessary than in low-lying plains, as, in order to obtain as nearly as possible the same climate on both, shelter must be artificially added to the higher grounds, in proportion to the natural advantages of the lower. We have often seen this wonderfully exemplified in hilly parts of a country, bordering on low-lying and flat ones. On the parts of the former character we have seen the farm crops better than, and as early as, on the latter; and this simply from the proprietors of the low-lying districts having neglected a judicious distribution of trees on their properties, while those of the higher-lying had attended to this point.

All undulating and somewhat hilly districts, then, should be well wooded along the ridges of the heights, in whatever direction they run, and even to some extent down the slopes on both sides, as by such means the lower grounds will be well protected from winds from all directions; but planting should be made in the hollows betwixt the hills to a moderate extent only, as heavy masses of trees are always unpleasant to the eye of taste in a cultivated part of the country.

330. Although we may not be able to grow such large and fine timber on the hilly parts of a country as we can on the lower, still it must be settled that the former are the only and proper districts for the cultivation of timber to a large extent, especially in a comparatively small country like Britain, in which the inhabitants are daily finding necessity for a greater breadth of cultivated land to supply the increasing population with food. This is a fact which no wise man will attempt to gainsay; and therefore it must be laid down as a rule that in any comparatively small country the object must be, in growing timber, to plant it sparingly, and only to ameliorate the climate on all good agricultural parts, and to cultivate it extensively for all purposes for which we require a supply of wood only on the hilly and poor lands, on which farming cannot be profitably pursued without its presence.

We state then, generally, that on all such high-lying districts of a country as will not admit of profitable farming, trees should be planted as the principal crop, and that to such an extent as to be limited only, on the one hand, by the better portions of the lower grounds being made arable, and on the other by the extreme elevation and poorness of the land not being suitable even for the growth of trees.

SECTION II.—IN EVERY COUNTRY THE CONSERVATION AND EXTENSION OF ITS FORESTS AND PLANTATIONS SHOULD BE CAREFULLY ATTENDED TO BY ITS LEGISLATORS.

331. The preservation of the forests of any country is a duty devolving on its legislators, not only in order that a sufficient supply of timber may be kept up perpetually for the wants and necessities of its people in their various pursuits of industry, but also with the view of ameliorating and improving the climate for their healthy existence and consequent greater usefulness as subjects.

332. But besides preserving existing forests, it becomes the duty of every Government also to plant trees extensively on all parts of the country not at present suitable for agricultural operations, and also to see that the landholders of the country do the same on their respective properties, all to such an extent as may be considered judicious in respect to the proper cultivation of the land everywhere,

and to the welfare of every class of the people under its laws. Where this has not been attended to, and the woods have been cleared indiscriminately, agriculture has failed to be profitable, and many large portions of country have become deserts, and left to nature. We could point to many countries where, at the present day, this unprofitable state of things is in existence; but we need not, as most people of intelligence are aware of the fact.

333. We have therefore to advise here that the people of every civilised country in the world should insist upon their rulers to reserve and keep in good condition all the existing forests of each respective country, and to plant all waste lands in it with trees where it is unfit for the rearing of food; so that agriculture may become more and more profitable, and therefore food more abundant for the wants of the people, who have a right to see this state of things brought about. This matter lies with the people themselves, and all should bear a hand to have it put into operation without further delay.

SECTION III.—LAYING OUT OF LAND FOR FORESTS AND PLANTATIONS.

334. A forest, in the common acceptation of the word among practical men, means either a plantation of very large extent, or a large district of country partly under trees and partly waste. As examples in illustration of the point, we may refer to the public forests of Delamere in Cheshire, Dean in Gloucestershire, and the New Forest in Hampshire, in all of which oak has been planted, and is being reared for the purposes of the State,—to the private forests of the Duke of Atholl in Perthshire, in which larch is grown to a larger extent than on any other property in the island,—and to those of the Earl of Seafield in Strathspey, in which the Scots pine is grown more extensively than on any individual property in Britain. All these forests are made up of a number of separate enclosures or plantations, of different extents and of different ages of crop.

335. There are comparatively few landed properties in this country so large as to admit of planting to an extent sufficient to warrant the appellation of *forest* being applied to their woodlands, as we do not think that an area much less than ten thousand acres is worthy of being called by this name. This, however, is merely a matter of opinion; and as it is practically of no importance whether the woodlands upon a property be called a forest in the aggregate, or by the names of the plantations respectively, we shall leave the point to be decided by the choice of proprietors.

336. Every piece of land enclosed as woodland, whether it may be of large or small extent, if its crop be planted and not of natural growth, is called a plantation; where the crop on a piece of woodland is of natural growth, it is by practical men called a wood; and therefore we generally find foresters speak of woods and plantations upon a property, meaning that the crop of the former is natural to the land, and that of the latter is artificial, and had been planted on it.

337. It is admitted by every person of refined taste, that no object is so ornamental upon a landed estate as an extensive healthy plantation, situated upon a well-chosen spot, and having a well-defined tastefully bending outline; and this being a point of the first importance in arboriculture, it ought to be well considered by all who would wish to excel in the profession. We are aware that many think, and indeed say, that forest-trees will grow as well in an untastefully defined plantation as they will do in one laid out upon the first principles of refined taste, provided that the soil be good enough,—which is a false estimate of what good taste is capable of doing. And in order to contradict this erroneous opinion, we do assert that a young plantation, laid out according to scientific principles combined with good taste, will succeed much better than one laid out in a careless manner, as will be shown by-and-by, under the present head.

338. As the future welfare of a plantation is considerably affected by the manner in which it is laid out, no man ought to attempt the laying out of land for one who is not naturally possessed of good taste for that sort of landscape scenery which is based upon the laws of nature, which will enable him to lay out the proposed plantation in such a manner as to give the greatest possible effect in ornamenting the neighbouring country. It is also necessary that the person who would lay out a new plantation should be possessed of a knowledge of the nature of the growth of each sort of tree when planted upon any given soil or situation, which knowledge will enable him to judge rightly as to the effects that certain trees will have when planted in any given spot; and he will also be enabled from such knowledge to say truly whether or not trees will grow well in the situation chosen for a new plantation. And it is further necessary that the party, in the laying out of a new plantation, should be acquainted with, or at least have in view, any local peculiarities of the district, relative to cold and destructive winds from certain points. From such knowledge he will be able to lay out the proposed plantation in such a manner that it shall have the greatest possible effect in giving shelter to the surrounding country, which is the principal end a proprietor aims at in having woods upon his estate.

339. The larger that any piece of plantation is, the sooner will the trees therein come to useful size, and answer the desired end; and the smaller it is, the more likely are the hopes of the planter to be disappointed. And the reason of this is obvious; for the young trees growing in an extensive plantation, as soon as they rise a little above the surface of the natural herbage, begin to shelter one another; whereas, if the plantation be narrow, the young trees can hardly be said ever to come the length of sheltering one another,—for every breeze of wind blowing through the whole breadth, acts upon each tree almost as powerfully as if it stood singly and alone. Therefore it is most profitable for proprietors always to plant in large masses.

340. Trees planted in a mass of 100 acres in extent will be more healthy, and come sooner to profitable size, both as affording timber and shelter, than they would if planted in a mass of 10 acres. From this it follows, that if a proprietor wishes to plant 100 acres upon his estate, he will raise more healthy timber by planting in one mass, than he would do by planting the same extent in four masses of 25 acres each.

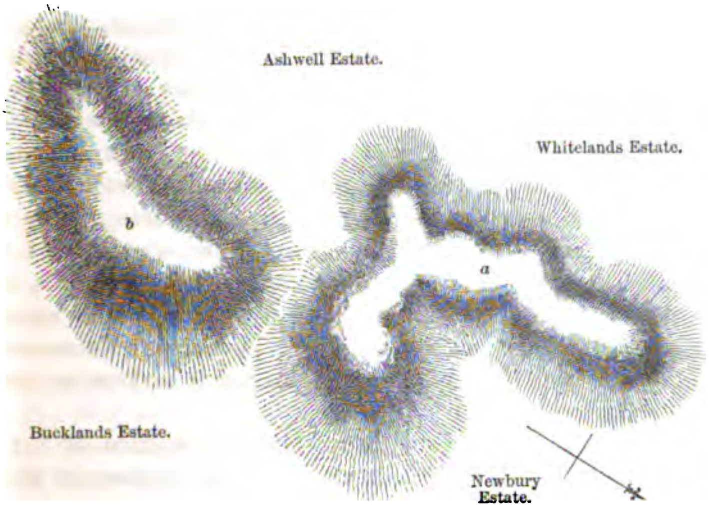
341. No young plantation, upon an exposed situation, should be less than 100 yards broad at any given point; and where the soil is of a light, thin, mossy nature, and not adapted to raise trees to good size, 100 yards may even be too little for breadth. If there be much mossy ground upon the site intended for a new plantation, or if there be much of it consisting of poor, thin, gravelly heights, as is often the case in unimproved districts, a narrow or small plantation will not succeed profitably. A small plantation may succeed upon a good loamy soil in a sheltered situation; but upon a thin soil, and an exposed situation, we would advise not to plant at all, unless it be done in large masses, say from 200 to 1000 or more acres.

342. Almost every landed estate lies in a manner peculiar to itself; the wind that might prove hurtful to one estate might not do so to another marching with it: therefore it is that the particular winds which prove most hurtful to an estate should always be taken into consideration in the laying out of a plantation upon it.

343. By referring to fig. 1, this peculiarity in the difference of situation affecting landed property will be at once evident.

The estate of Whitelands being situated upon the west side of the hill *a*, which runs nearly south and north, would be greatly sheltered from all storms of wind from the east and south-east; consequently, in laying down plantations upon the estate of Whitelands, the greater length of the same, in order to protect the land from the north and south winds, would require to be made from east to west; and if the situation were exposed to destructive west winds, plantations meant to protect the lands from it would require to be made from north to south. Again, Newbury estate, being situated upon the east side of the hill *a*, the lands upon it would be sheltered from the west and south-west winds, but would be much exposed to the north and east winds; consequently the same estate would require to be sheltered by plantations extending their greater length from east to west, which would protect the lands from the north winds—or from north to south, in order to protect from the east winds.

Fig. 1.



344. There being a considerable opening between the south end of the hill *a* and the north end of the hill *b*, as indicated in the figure—the north part of the lands of Ashwell occupying the west side of this opening, and those of Bucklands occupying the east—great care is necessary in laying down plantations under such circumstances; for either the east or west wind, passing through such an opening, gathers force from being confined in its passage between the two hills. Therefore, in order to protect each estate from the effects of winds passing through unchecked to either side, a mass of plantation would require to be situated right in the opening, having a convex side turned to the east, and another to the west, which would naturally turn the wind to either side, and cause it to spread along the hills.

Again, in order to protect the lands upon the west of Ashwell from the north, plantations would require to be laid off from east to west; and in order to protect them from the west, they should be laid off from north to south.

Upon the estate of Bucklands, again, the land requires to be sheltered more particularly from the north and east winds; therefore plantations laid out upon it with the view of protecting from these winds would require to be made from east to west in the one case, and from north to south in the other.

345. From what has been said, it will appear plain why one estate may be injured by the wind from a certain point, while another marching with it may not be injured by the same at all. Thus the estate of Whitelands, from being situated upon the west side of the hill *a*, is completely sheltered from the east wind; while, on the contrary, the lands of Newbury are naturally exposed to the east. The northern parts of both the estates of Ashwell and Buckland are, from their natural situation upon the opening between the two hills, nearly alike exposed to the east and west winds; while the southern parts of these estates are sheltered by the hill *b*, differently; therefore it is that, in the laying out of plantations upon any landed property, those matters which we have here endeavoured to explain by reference to fig. 1, must in all cases be kept in view by the intelligent forester.

346. We have already said above that the welfare of a young plantation depends in a great measure upon the manner in which it is laid out. We also said that a plantation laid out according to scientific rules, combined with good taste, will succeed much better than one laid out in a careless unscientific manner. The following are the rules by which we generally guide ourselves in the laying out of a new plantation:—

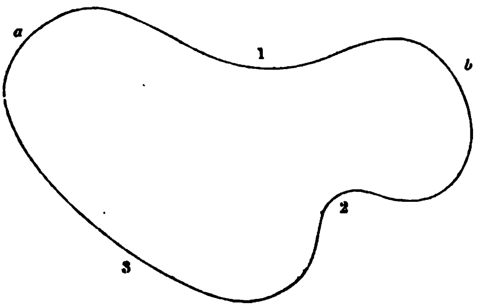
First, In laying out its boundary-line, avoid all straight lines upon the exposed sides; and, if possible, make no straight lines upon any side: they are disagreeable to the eye, and are without meaning when applied to natural objects. In nature there are no straight lines, and that for a wise end, for they are without strength to resist outward pressure.

Second, The greatest extent of a new plantation should be laid off against the prevailing wind of the district; and, at the same time, the greatest extent should be kept along the highest part of the ground to be planted.

Third, The best possible form of boundary-line which can be thrown out against the wind, upon the most exposed side of a plantation, is the convex. Such a form of boundary-line weakens the strength of the wind when it strikes upon it: the strength of the storm is, as it were, divided by the projecting bend of a well-defined convex.

Fig. 2 is a sketch of the outline of a plantation with its exposed sides *a* to the north, and *b* east, representing two convex bends thrown out against the storm from those points.

Fig. 2.



Now, from considering this attentively, it will at once appear evident that trees growing behind a bend of this description, and the outer trees forming themselves the bend, are, from the position in which they are arranged, proof against the effects of storm, as compared with others forming a straight line, or a concave bend. Upon the convex bends, as at *a* and *b*, when the wind hits, its force is weakened, because the line of fence recedes from the wind, as it were, at any given point; and in proof of this we may refer to the action of the sea upon the differently shaped bodies which may be made to pass through the water. For example, the forepart of a ship is nearly of the convex form, and when the water strikes upon it, it spends itself along each side of the vessel. Again, were a ship to have its forepart made flat, it could not be urged through the water at all; and further, were it made concave, instead of the vessel being made to go forward, it would be driven back. This is exactly the principle of the action of the wind upon the different forms of fence-lines; and from this we see that the concave bend is the worst for the purpose of protecting from the storm anything behind it; consequently, in making such a bend in the line of a plantation-fence, great discrimination is requisite to know when it should be made.

Fourth, Upon the most sheltered sides of a plantation the boundary-line may be made to bend one way or another, as good taste may direct, but in all cases making a concave bend only where there is a good breadth of planting immediately behind it.

By glancing at the concave bend 2, it will be observed that it is backed by a great breadth of planting from the north *a*, and is also well protected by the convex bend *b* upon the east; besides, its situation is upon the most sheltered side of the plantation—namely, the south; and such concavities may be made upon the same principle, few or more, according to the extent of the ground planted, and also as the private taste of the proprietor may suggest. In general cases, the fewer of them the better for the welfare of the plantation; where stock are to be sheltered, it is often necessary to make them. For example, if there was no concavity at 2, and the storm blowing from the east, cattle could have no real shelter along the edge of the wood at that point; but in such a bend in the outline of a wood as shown at 2, stock could not receive any injury excepting from the south, which is, generally speaking, not subject to stormy weather in the northern hemisphere.

Fifth, The highest parts in a neighbourhood, if they are not too high to admit of trees growing profitably upon them, ought to be chosen for the site of a plantation. By choosing such a situation, the greatest possible shelter is likely to be attained for the fields of the neighbouring country: and, at the same time, a plantation situated upon a height always forms a prominent and a pleasing object to the proprietor. A bare height, at only a moderate elevation, always carries along with it the idea of barrenness; but when planted with trees, it forms one of the most pleasing objects in the landscape of an estate.

Sixth, In the laying out of a new plantation in a high, exposed country, intended principally for the protection of live-stock, there ought to be several rather deep sinuosities upon the most sheltered sides. These sinuosities ought to be upon a bold wide scale, so as not to cause any weak point to project from the body of the plantation; for if this be the case, such weak points would not thrive, and consequently always have a mean appearance.

Seventh, If in the general arrangement of the boundary-line it should be found necessary to make a bend having its concavity to the storm side, care should be taken to construct such a bend in a hollow part of the ground, or at least as low as possible; and it should be backed by a good breadth of planting behind. See fig. 2 at 1.

347. The bendings in the outline of a plantation should always be made to follow the natural rising and falling of the ground—that is, where any lateral heights may project from the main body of the land laid out for a plantation, make the fence-line take a bold convex turn in the same direction, and that just so far as may be considered necessary for the extent in view; and where a hollow of the ground occurs, make the fence-line take a bold concave turn there, coming up again in the form of the convex where the ground begins to rise.

This will be more fully understood by referring to figs. 3 and 4.

Fig. 4 represents the side of a hill as laid off for a plantation, and the dotted line represents the fence. The concave bend *a* is made in a hollow, sheltered part; and the convex bend *b* rises over the high ground adjoining, but is not extended to the extreme tail or bottom of the hill-ground,—because it may be, and often is, found extremely advantageous to retain a part of such high ground in the field, in order that sheep and other stock may have the benefit of the same for lying upon at certain seasons of the year when the lower grounds may be in a damp state; and besides, we have already said that the bends need only be extended so far as may be considered practicable for extent and general purposes, but in all cases the retaining of the form of the natural ground should be kept in view. The concave bend *c*, it will be observed, is made to extend far back into the hollow ground; for such a hollow part, when sheltered by plantations nearly all round, is one of the greatest benefits possible for stock at all seasons, both as regards storm in winter and shade in summer, and more particularly if the bottom there be dry.

Fig. 3.

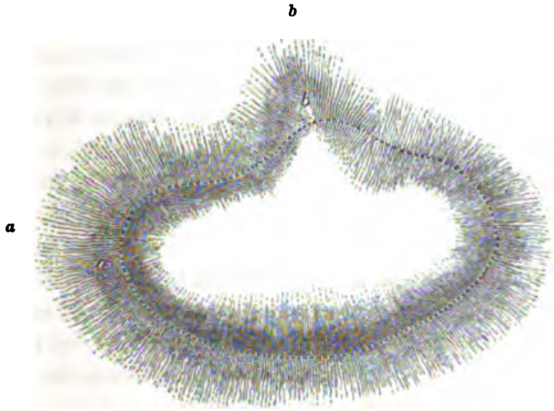
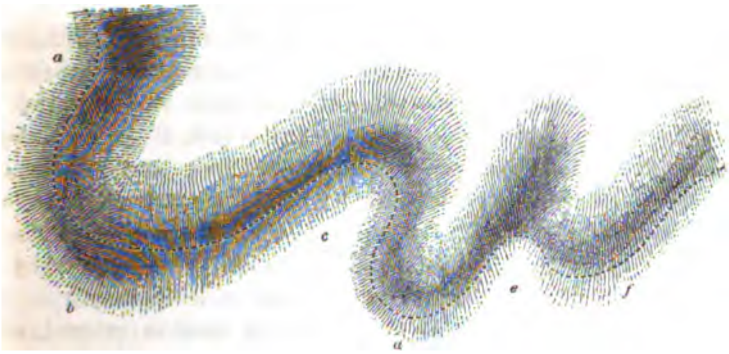


Fig. 4.



The convex bend *d*, again, is extended beyond the tail or bottom of the hill-ground, and that in order the more effectually to add shelter to the adjoining hollow part *c*; and the same remarks apply to the concavity *e*, which is also much sheltered by the bends *d* and *f*. Now these points are most necessary to be attended to in the laying out of woodlands upon hill countries, where, indeed, the welfare of stock is often more to be taken into consideration than the giving of mere shelter to field-cropping.

Fig. 3 is the representation of a hill which it is wished to form into a plantation in an exposed district. At *a* the hill-ground runs out to something like a mere point, and in this case the line of fence is kept a little higher, in order to give the convex bend a bolder and wider turn; for we have already said that all weak projecting points ought to be avoided in the proper laying out of a plantation-boundary; and had the fence-line at *a* been brought out in the exact natural form of the tail of the hill, a mere point would have been made, which should, in all cases of this nature, be avoided. And the very same remarks apply to the projecting point of the hill at *b*, where the fence is also kept back in order to strengthen the interior; and by the same being thus kept a little back, the appearance is improved, and yet in all these cases the natural form of the hill is retained.

348. In the laying out of a new plantation, if it is at all to be seen from the windows of the proprietor's mansion, or from any part of his pleasure-grounds, great care should be taken to make it have the most pleasing effect when viewed from such points; for if it should be badly laid off it will prove a continual eyesore, and if well laid off it will form a constant source of pleasure.

349. Besides the converting of hill-ground into plantations, there is also to be considered the planting of ravines and other local hollows, which would be otherwise of very little value to the proprietor for any agricultural purpose, but which, if at all adapted to the growth of trees, under skilful forestry may be made the most profitable of all situations for the growing of timber. And, relative to this, we must say that, even upon a very inferior soil, trees will succeed far better upon slopes and in hollow parts than they will do upon a rich piece of land situated upon a level country. This appears to be most natural to the welfare of trees in general, which is a wise provision of nature, seeing we cannot cultivate such land profitably in the rearing of any other crop.

In the laying-out of such hollows or ravines for the rearing of plantations, we may remark here that the fence or boundary-line ought to be made for the greater part to follow the undulations of the brow of the ravine—that is, the boundary-line of the ground to be planted in the hollow should be made to correspond, so far as other local circumstances will allow, with the natural line of the tail of the background above and the head of the slope; for this is the system which gives the most pleasing effect. But in saying this, we by no means wish to be understood as advocating that nothing ought to be done in order to improve upon the natural appearance of such irregularities as we often find existing along the edges of hollows or ravines; on the contrary, there is no part of forest architecture in which there can be more taste displayed, not only with the view of giving effect, but with the more important view of giving the benefit of increased shelter from storm to the cultivated grounds along the sides of such parts.

It is well known to all country people, that in glens or hollows of any extent there is generally a draught of cold wind rushing along when the same is not sensibly felt upon the higher grounds above—at least, any considerable distance back from the brow of the hollow; and such cold winds are often very hurtful to crops in the adjoining fields, particularly in the case of frost and cold damp in the spring months. Now, in order to prevent the evil effects of such draughts of damp and frosty winds in the spring, it is very proper to have convex bends rising out of the ravine or hollow, at well-chosen points, and extending a considerable way upon the level ground above, and always endeavouring to bring up such a bend at a part most likely to intercept the rush of wind from the ravine to the higher grounds; and such bends should not be made upon a small contracted scale, but to a considerable extent, by which means the ground above is greatly protected from the effects of sudden gusts of wind, which are very apt to arise from such parts, and which are almost always hurtful.

350. Many maintain that the planting of hollows with trees adds very little to the shelter of the neighbouring country; but in this we are decidedly of a different opinion; for the very existence of trees in a hollow sifts the wind passing through it, and very much impedes its passage and softens its temperature; more particularly, when projecting parts are made to jut out at proper and judiciously chosen parts upon the level country much good is done. And not only do such juttings prove beneficial as regards shelter, but they, in our opinion, add greatly to the general effect of the whole, as appearing most natural, and agreeing with a refined taste.

351. The method of laying out plantations in the form of strips, so often to be met with in many parts, gives a poor and mean appearance to an estate. The form in which they have generally been made is in straight lines, from 20 to 40 yards broad. In such narrow belts of wood the trees are very seldom found in good health, and, upon a little consideration of the matter, this is not to be wondered at—because, from the narrowness of such strips, the proprietors were always afraid to thin them, wishing to keep them in a thick state, in order to give as much shelter as possible; and the natural consequence is, from being left too thick, the one tree soon injures the other. And even where such strips have been well managed, it cannot be expected that they could produce either good or healthy timber, or make a good shelter; for, being so narrow, the trees never come to shelter one another. But it is a happy circumstance in the

history of arboriculture, that few such strips are now planted. Most landed proprietors are now beginning to see the impropriety of such a method of raising plantations; and now, in almost all cases of good management, we see the old-fashioned narrow strip giving place to the well-defined extensive plantation, which is, indeed, the only profitable way of rearing trees for any useful purpose.

352. And, in conclusion, upon this head, we beg to say that we have, in all cases of good management, found hedgerow trees infinitely superior in every respect to narrow strips of plantation, even where such were under what might be considered fair management. Trees in narrow strips seldom live to great age, from the want of space, even when tolerably managed; whereas hedgerow trees, when properly reared, attain, from having ample space, their full natural vigour and dimensions, and live to double the age of trees found in a strip; and when allowed to grow rather closely together, they make a much better shelter than an unhealthy strip. Therefore, in all cases where land is considered of great value for farm-cropping, and where strips cannot be made of sufficient breadth, we would recommend the planting of hedgerow trees in preference to the usual method of planting narrow strips.

SECTION IV.—UTILITY OF FENCING AND PROPERLY ENCLOSING LAND FOR THE GROWTH OF YOUNG TREES.

353. It is absolutely necessary that every piece of land laid out for a plantation should be fenced in some way or other previous to its being planted. A fence not only prevents the inroads of sheep and cattle, but at the same time tends very much to shelter the young trees, and to bring them on rapidly. It is indeed surprising to observe the difference that a very low fence makes upon the growth of young trees, as compared with those which are not protected by one. Any proprietor or forester, upon looking through his several plantations, will observe that in all young plantations the most rapid growing, and at the same time the most healthy trees in it, are to be found immediately behind the outer fence; and on the other hand, in all older plantations, the best grown, and at the same time the most healthy trees, are to be found in the centre of the same, or at least a considerable distance back from the fence. Now it may be asked, What is the reason that the best wood is found in the inner parts of old plantations, while the most rapid-growing trees are to be found when young behind the boundary fence? The reason, as proved from experience, is this:—

During the first eight or ten years of the age of any young plantation, the boundary fence is the only shelter that the young trees have; and it is evident that those trees which grow immediately behind the fence will receive most of the benefit of its shelter; consequently, from the circumstance of their receiving more shelter than their neighbours farther off, they must grow more rapidly, until such time as their tops begin to rise above the level of the fence, when they are considerably checked by the cold winds. At this stage they begin to grow thick and bushy rather than advance in height; and immediately upon their becoming so, they begin to shelter all their neighbours inside, which again begin to have double the advantage of their neighbours outside;—for the trees upon the outside had shelter only so long as they were below the level of the top of the fence; whereas those inside have now a shelter which every year increases upon them for their advantage, in height as well as in thickness. All this comes in to prove that a fence is a great means of furthering the healthy development of a young plantation, independent of its protecting from the inroads of cattle at the same time.

354. It may not be out of place here to state the great necessity there is for keeping good all fences which surround plantations, to a period beyond that at which it is likely that the trees will be injured by the access of sheep and other live stock; and especially as we have often had occasion to remark the evil effects of sheep in particular being allowed to have access to plantations at an early period, we find it the more incumbent upon us to point out the evils arising from such a habit being allowed upon many estates.

355. Upon many estates we have observed sheep and other cattle grazing in hard-wood plantations not above twenty-five years old, and this was allowed under the impression that the rent which was received for the grazing did more than any additional benefit which could be derived from an opposite system of preserving the trees by fences. This, however, we beg to say, is a practice very injurious to the welfare of any young plantation; for sheep in particular, when allowed to have free access into any plantation composed of trees in a growing state, and having their bark smooth, are certain to injure the same, from the greasiness of their wool coming in contact with the bark and impeding the action of light and air. Upon the other hand, heavy cattle, when allowed to graze in a plantation of small extent among growing trees, are always inclined to hang about under their shade in the warmer part of the day, at which periods they invariably commence gnawing the bark, which is smooth upon such young trees, as well as the shoots of the tender branches where they can reach to them. Therefore we would advise all proprietors, as they value the welfare of their plantations, never to allow cattle of

any description to have access into a plantation, unless the trees in it are considerably advanced, when the bark of most forest-trees becomes hard and covered with rough scaly protuberances, which resist the action of either the greasiness of the sheep or the teeth of large cattle. It may be asked at what stage would it be safe to allow the grazing of cattle to take place where trees are? In answer to this, we give it as our opinion, that after trees have attained the age of nearly forty years, and have received their final thinning, they may, in the generality of cases, be considered safe from the inroads of cattle.

356. Many different methods of fencing have been adopted for the enclosing of young plantations, &c., upon landed property, and no doubt different methods will still continue to be adopted according to the different sorts of materials to be had in abundance in the neighbourhood of the plantation or other enclosure which may require to be protected; and as fencing is often a very important part of a forester's duty, we shall enter rather minutely into detail upon the method of erecting the different sorts of fences, and shall show the advantages of one sort over another, in so far as they are suited for different purposes, and for different situations, with any other particulars relative to them that may be useful to the practical forester. And before leaving this section, which is merely meant to point out its advantages, we may be allowed to say that every practical forester ought to make himself as nearly as possible master of the art of fencing in all its most useful parts. Having ourselves, in the act of visiting landed estates, seen much of the great advantages derived from men acting as overseers upon estates being well up to this sort of work, as well as the disadvantages to proprietors of having men as overseers who were not well acquainted with it, we are the more anxious that this art should be properly understood both by foresters and land-stewards; because, from possessing such knowledge, they are the better able to be intrusted with the improvements which may be carried on by the proprietor in whose service they are employed. We shall not confine ourselves strictly to the description of fences which may be considered adapted to the enclosing of woodlands: we shall also point out the method of erecting fences adapted for parks and pleasure-grounds, the knowledge of erecting which is often as essential to the forester and land-steward as that of cultivating the soil for their respective crops.

SECTION V. — COUNTRIES WHICH HAVE RECENTLY BEEN DENUDED OF THEIR NATURAL FORESTS MAY HAVE CROPS REPRODUCED TO A LARGE EXTENT, WITH COMPARATIVELY LITTLE PLANTING, BY ENCLOSING THE LAND.

357. In countries which have lately been to a large extent cleared of their forest crops of natural growth, as is the case in respect to the United States and Canada at the present time, much of the land so cleared could be readily again occupied by trees, were it properly enclosed, so as to prevent cattle having access to destroy the young plants as these rise on it.

358. From our own observations while travelling in these countries, we are confident in stating that large tracts of the land now lying in the unprofitable condition referred to, would produce, within a few years, a young and promising crop of nearly all the kinds of trees that formerly grew upon them, were they only protected from the inroads of cattle by fences erected around them. In nearly all cases where clearings of the forests have been made in North America, young seedlings immediately rise all over the ground, which would soon grow up a thick and healthy crop, were it not that cattle eat them as they appear above the surface, and thus they are prevented from rising so as to form crops of any value. In many parts of Canada we have observed that where the forest had been cleared, and where cattle were not kept in any considerable number, the cleared land became again covered with a dense crop of trees within a very short time, which grew rapidly, and could have been made valuable had attention been paid to thin the trees and give the better ones room for development.

359. This natural law of reproduction, in respect to trees, is taken advantage of to a large extent in many parts of the continent of Europe, where such young growths are attended to, and made to become parts of the succeeding crops in the forest enclosures, so that from taking advantage of this, comparatively little replanting is needed to secure crops over all the ground.

360. The same thing is now being attended to on a large scale in Australia and in New Zealand. There, where large portions of the natural forests have been cut down, the Governments are enclosing the land and attending to the young trees which spring up naturally on it, and in this way healthy crops are being established, where formerly only the rubbish left from the clearings existed.

361. We think it well to bring this fact under notice, as, were it properly acted upon in all countries having lands in a similar condition of unprofitableness, new crops would ere long be established,

and only a small outlay afterwards would be required to plant spots where young trees had failed to come up.

SECTION VI.—REARING OF TREES IN TOWNS AND CITIES, WITH THE VIEW OF SECURING ORNAMENT, SHELTER, AND SHADE.

362. It is now a recognised fact that trees purify the air, and are the chief means of maintaining it in a normal condition, and therefore rendering it fit for the support of animal health and life. This being the case, it is evident that a systematic distribution of trees, in places where large bodies of men are congregated together, must tend very much to promote the health of the community, by absorbing the impure air which must necessarily attend such places.

363. But besides being directly conducive to health in the way stated, trees are also highly beneficial to life, inasmuch as, when properly distributed and arranged, they secure an amount of ornament, shelter, and shade which must reasonably be supposed to be favourable to health in towns and cities, by giving pleasure to the eye, shelter from the cold and cutting winds of winter, and protection from the rays of the hot sun of summer.

364. In most of the large towns in Britain the inhabitants live in a state which in all respects may be said to be artificial. In their shops they see nothing but the works of their own hands, and when they go out to the crowded streets they see only the dull walls of stone or brick wherever they turn their eyes—there is not a tree with a green leaf to cheer their wearied senses; and is it then to be wondered at that their feelings become disordered, and break out into all imaginable extremes of conduct, as we too often have proof of in reading the public papers? The grand cure for this diseased state of humanity in large towns is to place the inhabitants more in contact with nature in their everyday employments. Give them to see the trees of the forest as soon as they step out of their workshops, and to hear the rustling of the wind and the pattering of the rain as it falls on the leaves while they walk along under their shade and shelter, and assuredly their minds will be soothed and called to reflect on nature and on nature's laws; and, as the result, to feel a happier existence, and to show this by living a more natural and more useful life.

365. The making of parks, squares, and gardens in a town or city is no doubt highly commendable, and these form noble features in the architecture of our hives of industry; but it is evident that they but partially supply the necessities of most of our large towns, as the greater part of the inhabitants cannot always be in or near these

parks and gardens; and many, it must be admitted, never see them at all except at rare times, considering that they are generally laid out as far as possible from the busiest thoroughfares, and some of them only open to a few of the more wealthy individuals in their neighbourhoods. What we yet require are trees planted along the streets of our populous towns, so that all, both rich and poor, old and young, may equally and at all times, through the day and at night, enjoy their shade and shelter, and breathe under them the fresh and invigorating air of heaven, and thus produce to the inhabitants something of nature's purity, even in these tunnels of smoke and dirt.

366. This, we are glad to see, is a subject the importance of which is daily becoming more and more recognised in this country, but up to the present time it is one which has been very much neglected in the erection of our towns and cities. For example, that such a city as London, in particular, in this nearly the end of the nineteenth century, where nearly four millions of people are congregated together in densely packed masses, should be *comparatively* without trees along its streets, must be humiliating to every sound-thinking Englishman in the present age of enlightenment, while sanitary measures of every other imaginable description are being ventilated from north to south. This is the more surprising when we consider and compare some of the cities on the continent of Europe and in America, with their well-arranged streets and promenades, and avenues of beautiful trees, with those of our own, with their dark, dirty, and naked-looking streets.

367. Paris at one time, we know, was a very close and dirty city, and now, within a very few years, it has been converted into one of the most pleasant and healthy character. This change has been brought about simply by the formation of the "Great Boulevards" from central points running in all directions through the city. These boulevards, we may here explain, are wide, open streets, bordered with beautiful trees, and flanked by broad and well-made footpaths. They run to a great length in one direction through the city, while others are made running round the city, so as in all to form a kind of open network. They are generally about 100 feet wide from house to house, but occasionally they are about 140 feet in width, and even more in some of the outer ones; and the side footpaths of the more frequented boulevards are generally upwards of 20 feet wide.

368. The trees, when planted in the streets of Paris, are nearly all young, and have previously been pruned and trained so as to form a clean-stemmed plant with a straight leader, and when planted in the streets they are protected by a cast-iron or wood-work basket. They are supported with stakes when young, and these supports are

kept good till the trees are strong enough to do without them. In order to ensure the earth about the roots of the trees being kept in a loose and porous state in the more frequented parts of the city, each tree is provided with a cast-iron grating, about 6 feet wide. They are planted at a distance of about 18 feet apart in the lines, and from 3 to 4 feet from the edge of the pathway. This planting so close is to provide immediate effect.

369. In preparing the ground for the planting of the trees, a trench is dug for every one, of about 6 feet in width, and from 4 to 5 feet deep; and before inserting the tree, drain-pipes are laid along the sides of the trench, made with lapped joints so as to prevent the roots from entering them. The trees are then planted, each being selected with perfect roots, and in all respects a good, well-balanced, young tree. If the weather be dry at the time of planting, the trees are supplied copiously with water, and the kinds generally planted are the *Platanus occidentalis*, horse-chestnut, elm, &c.

370. The Americans, as well as the French, are alive to the advantages of having trees planted along the sides of the streets in their towns and cities, and there we find this branch of tree-culture very much attended to, which gives the most of the large towns in America a clean, cool, cheerful, and airy aspect. We may only refer to the cities of New York and Philadelphia in the United States, and to those of Montreal and Toronto in Canada. In all these we have seen very fine specimens of most of the deciduous kinds of trees indigenous to America growing along the sides of the principal streets, forming beautiful avenues of verdant growth, spreading from the edges of the streets up to the windows of the houses on each side, from which the families occupying the second and third stories could put out their hands and gather leaves and flowers. In the summer season, when the hot American sun pours down his intense rays upon these towns, the shade of the trees planted along the sides of the streets is most agreeable and refreshing, causing a cool and invigorating draught of air to circulate along the streets. What a contrast this is to our towns in Britain, where nothing but the lamp-posts stand out on the streets, and where every one is exposed to the draughts of cold air and scorching of the sun-heat, without a single tree to shield us from the bad effects of either!

371. The kinds of trees planted along the streets in the American towns are all of the deciduous kinds—plane-tree, elm, chestnut, hickory, poplar, maple, butternut, false-acacia, and others; and they are all planted in a tasteful manner, so as to produce variety in the foliage as much as possible. Nothing can be more beautiful and agreeable than the foliage of these trees both in summer and autumn; and this gives an effect to the streets which is quite enchanting to

the visitor from this country, who is not prepared to expect such a state of things, from his not having been accustomed to see it in the towns in Britain.

372. In the American towns the trees are planted in holes, prepared for them in the same way as has been described in regard to the planting of those in Paris, but at from 25 to 30 feet apart in the lines, and in most cases from 12 to 15 feet from the houses on each side, and they are generally protected for a time by a guard of strong wood-work. Here the trees grow very rapidly, and in a very few years they become so large and overgrown that liberal pruning has to be applied on all sides to keep them within bounds, and to prevent them shutting out the light from the windows of the houses and encroaching on the traffic of the streets. Therefore in all the large towns there are men whose duty it is to attend to the trees. These are called town foresters.

373. In the neighbourhood of all the principal American towns there are extensive nurseries, in which young trees are reared solely for the purpose of transplanting into the streets. In these nurseries the trees are carefully trained to a necessary height and strength before they are removed, and this is generally from 12 to 15 feet high, with a stem from 3 to 4 inches diameter at 4 feet up.

374. In Paris, nurseries are entirely devoted to the rearing of trees for planting in the boulevards, squares, and gardens. There is one at Petit Bry, near Nugent-sur-Marne, which consists of about 45 acres of ground. From the locality of the ground being at times flooded by the river Marne, and thus apt to destroy the young plants, ridges of earth are formed, of about 6 feet in width, on the top of which the plants intended for the avenues in the city are inserted, at about 3 feet apart. This necessary precaution of raising the plants above the common level of the ground so as to be out of the reach of the river water, has also proved an advantage, inasmuch as the trees, being planted in the loose earth of the ridge, are placed above the general level of the ground, and consequently are much easier removed for transplanting, besides their having a better supply of fibrous roots than they could have if otherwise dealt with.

375. When the young trees are sent out of the nursery for planting on the boulevards in Paris, they are found all well-trained, straight-stemmed plants, with nearly uniform heights; and they must have a clean stem of about 10 feet in height and 3 inches in diameter, with a corresponding well-balanced top.

376. The foregoing statements in respect to how the French and the Americans go to work in the rearing of trees in their towns and cities, with a view to ornament, shelter, and shade, are sufficient to convince us that we are very far behind the age in this branch of

tree-culture, notwithstanding the parks and gardens in connection with many of our towns. These are only a part of what is wanted, and to the masses of the people can only be taken advantage of and enjoyed on Sunday or on a holiday, but are not adapted to promote the health, morals, and happiness of the working classes in their everyday life. It is therefore to be hoped that a new era is about to commence in this country in respect to the planting of trees in our towns and cities, and that ere long we will find all classes in towns enjoying the luxury of walking the streets under the shelter and shade of admirable trees, as these are at all times calculated to elevate the minds even of the most degraded of our race.

SECTION VII.—ORNAMENTAL PLANTING IN THE PARKS IMMEDIATELY SURROUNDING THE RESIDENCES OF LANDED PROPRIETORS.

377. Every forester who aims at anything like taking a high standing in his profession should be able to produce plans for and carry out ornamental planting on the parks immediately surrounding the residence of his employer, as well as to attend to the management of the outer plantations on the properties. There are few foresters, however, who can undertake and execute with true natural taste this branch of the profession, because it involves the study of trees in a pictorial point of view, and as forming individual parts of the general natural scenery of a neighbourhood, in connection with hills, ravines, plains, undulations, &c., on the one hand, and with natural woods, lakes, or river on the other, as may be in existence on the field.

378. Therefore, before a forester can undertake, with any chance of his doing credit to himself, or of giving his employer satisfaction, ornamental planting in the park surrounding a mansion of any pretensions, he must have studied the subject of trees in reference to the form and magnitude that each species is likely to take on the site and soil he is to operate upon; the outline that each species naturally assumes as it is observed resting on the background, whether that may be a grass-covered slope, the sky, or other trees; the prevailing colour of the bark and leaves of each kind; the effect of grouping each kind separately, and that of intermixing them, whether on low lands or on hill-sides or hill-tops; and the combination of all these points, in order to form a perfect and therefore pleasing picture out of the natural features of the field, together with the trees as arranged and planted on it. For the information of foresters who may not have devoted their attention much to this very important branch of arboricultural study, we shall devote a few paragraphs to the explanation of the principal points to be kept in view in the laying-off of planta-

tions on the parks surrounding the seats of landed proprietors; afterwards we will give some practical directions as to the best mode of rearing trees for planting out on parks, so as to produce immediate effect within as short a time as is consistent with perfect success in attaining the object in view.

379. The first point to be taken into consideration, preparative to the object under notice, is the situation of the mansion-house. This should be a considerable way back from a public road, and, if possible, equally as far from a town or village. The house should be situated on a gentle slope, facing the south, with rising ground behind, on which to form a background of woods. The park should extend from the house southwards, eastwards, and westwards, and should embrace a field not less than 150 acres, and should be bounded by roads, or the farm-fields of the estate. It should not have a formal outline, such as a square or a circle, but should be irregular and natural-looking in this respect; and, if possible, it should be much longer than broad, so as to give the command of an extended view from the windows of the house southwards in front. In its surface the park should, where practicable, be of a varied and somewhat undulating character, as a dead-level surface always produces a dull effect; and the boundaries should, as it were, run into the country beyond, without showing any distinctly defined terminations; and where there is a running stream, or a natural lake, these should be embraced.

380. The rising ground behind the site on which the house is now supposed to be built should be planted with trees of kinds to suit the soil and part of the country, keeping in view to use a considerable portion of the coniferous kinds, in order to their dark foliage forming a better background for a mansion than the lighter green of the leaves of the hard-wooded kinds. This is a point not generally attended to, and hence we often see the outlines of a mansion-house so much blended with the colour of the trees behind it as to be but faintly seen till it is near at hand; while, when the background is made up, in great part, by trees of a dark-green colour, the outlines of the building are brought prominently out, and therefore the house is seen to much advantage from a great distance. The plantations on the rising ground behind the house should be made to extend so far back as to secure the appearance of a continuous wooded district in that (the north) direction, when seen either from the park in front, or from the roads in the country beyond it to the south. This gives an extensive aspect to the domain, and withal adds to its appearance a degree of comfort and security it could not otherwise present. The plantations on the north side, or back of the house, should be laid off so as to spread out wings on the west and east sides of it—that is,

so as to embrace the house on these sides, coming down from the higher ground with a bold sweep on each side, and thus produce shelter from three points—the north, east, and west—leaving the view open from the house to all points from the east on the one hand, round southwards to the west on the other.

381. All along the boundary of the park, plantations should be laid off in such a way as to exclude any objects which it may be considered desirable to hide from the house and park, and to bring more prominently into view any that it may be considered desirable to be always under the eye of the proprietor. In laying off these plantations along the boundary of the park, they should be made to come into it with bold bendings at well-chosen points according to the natural undulations and other peculiarities of the district, and at the same time particular care should be had to make corresponding sinuosities, and here and there glades showing the better features of the country beyond. Nothing like a continuous belt of wood should be formed on the boundary, but only well-defined plantations, the position of which can only be determined by a careful and tasteful consideration of the field, and the different objects surrounding and in connection with it on the spot.

382. The park itself should be broken up by groupings of trees of different kinds, in various proportions of intermixture, and particular kinds separately, all as the case may require to bring out a perfect, and natural picture of the whole scene in all its diversity of bearings, and in all its connections, both in respect to itself and the frame surrounding it. In the immediate neighbourhood of the house the field should be left pretty open, forming an irregular lawn, with only a few of the very best specimens of trees on it, and such as may be considered in all respects ornamental, or at least likely in time to become so; and gradually at greater distances from the house the park should be dotted with groups of trees, and with single specimens, making the groupings and massings more extensive as the distance becomes greater from the house; but in no case should the massings and groupings be made so large, or come so close together, as to show a heaviness approaching to a continued wood; on the contrary, the whole should form such an agreeable blending of wood, field, water, and other objects in the neighbourhood, as may produce pleasure to the eye and the other senses, without the appearance of any point, whether in the blending of the colours or the arrangement of the objects, to offend the eye of the most refined taste. Any sheet or running stream of water that may be embraced in the field should not be shown as of one piece from any part of the park, but should be, as it were, broken up into several portions, by planting trees and bushes at proper points on its sides, so as to cause the one sheet or

stream to represent several, and thus produce the appearance of a greater extent of water than really exists.

383. The whole field beyond the lawn should, when finished, represent natural forest scenery, with open glades occasionally to bring into view the distant prospect of any picturesque object in the surrounding country, and with thickets to blind objects of an opposite character: and in attending to this, all advantage should be taken of the natural inequalities of the surface, so as to bring out the whole to represent natural scenery.

384. The principal approach to the residence should enter the park at a point of its boundary where there are some old and picturesque trees, and where an open glade has been left for a distant view of the country beyond. Here it should enter and be continued through the field by one regular bold sweep for a considerable distance, carrying it along so as to obtain the most commanding views of the park itself, and of the scenery beyond it, and, if possible, so as to keep the mansion-house out of view for the first half of its length. This object attained, it should next be led in such a way as to give the best possible view of the water, whether a stream or a lake, and of its wooded surroundings, when it should by a contrary bend be carried gracefully towards one of the ends of the mansion, where a glance of a flower-garden may be had in passing, and thence round to the front door, from which point the park should be seen as one grand whole. Of course the principal approach should be introduced into the park at a point near the railway station of the district, while other ways may be made to other points from the back parts of the mansion as may suit the objects in view, whether these may be for the convenience of the kitchen, the garden, the stables, or that of getting at the country lying to the north of the house.

385. The kinds of trees should consist of all that may be considered suitable for the district and its soil, but the greater portion certainly should be, if the place is in a favourable part of the country, oak, sycamore, elm, a few Spanish chestnut and horse-chestnut, with maple, lime-tree, and beech; with, of course, a suitable proportion of larch and other coniferous kinds on properly chosen parts, so as to produce effect with the other kinds. But besides these common kinds of trees, there are many others which should be introduced, and that, too, pretty largely, such as the Douglas fir, the Indian cedar, and various hardy kinds of silver fir, pine, thuja, cupressus, &c., all of which are calculated to produce both useful timber and ornamental effect.

386. We shall now, as was proposed, give a few practical directions as to the best mode of rearing trees for planting out on parks,

so as to produce immediate effect within as short a time as is consistent with perfect success in attaining the object in view.

When it is arranged to build a mansion on a certain site, the park in connection should be laid off, and its surrounding plantations made without delay, in order that they may have attained some growth by the time the house is completed. These surrounding plantations may properly be planted with young trees in the usual way of forming other plantations on the estate; but in clothing the park itself with its groupings and single trees, the plants for these should be reared in a nursery formed temporarily for the purpose in a corner of the park, and planted out on it after they have attained such a size as to produce immediate effect when planted.

387. The site for this nursery should be chosen in rather a sheltered part of the field, where the land is of a loamy, free, and open character, and the extent required will of course depend upon the number of trees that will be necessary to clothe the field, and this again will depend on the extent of land embraced in the field. The forester having ascertained the number of trees he will require for the clothing of the park, with all its groupings, &c., he will next calculate how many of them may be reared on an acre of nursery-ground when planted in lines at 4 feet apart and 6 feet between the lines. He will find that, at these distances between the young trees, he will be able to plant, in round numbers, 1800 plants on the acre; so that, having ascertained this point, he will at once know how much land to enclose for the nursery in order to rear the number of plants he requires.

388. An extent of ground enclosed as a nursery for the rearing of the young trees, suitable to the object in view, the forester will next lay the whole off in the form of *beds* 4 feet broad, with an alley or path 24 inches in breadth between every two, thus making the beds 6 feet broad from centre to centre of the alleys. This done, he will take a full spit and shovel of earth out of each alley, and throw it on its corresponding bed, thus deepening all the alleys to about 9 inches, and raising the beds correspondently. On this soil now laid on the beds, well-rotted manure should be laid to the depth of about 2 inches, which should be slightly dug in immediately afterwards, and this will complete the preparation of the beds for the reception of the young trees to be planted on them.

389. The young trees should now be selected from a public nursery, taking care to have all the deciduous kinds from 4 to 5 feet high, and the evergreens or coniferous kinds from 1 to 2 feet high, according to their rooting natures respectively. In choosing plants for such a purpose as is under notice, none should be taken but those of the most healthy, well-rooted, well-branched, and clean-stemmed charac-

ters; for if these points are not attended to, there will be difficulty experienced in afterwards training them to make really good and well-grown young trees for the purpose. The plants of all the different kinds required chosen as advised, they should be brought to the nursery and sheughed there preparative to their being planted in the beds.

390. In planting them in the beds, the roots of each individual should be *placed on the surface* of the manured ground, and the plant held in its upright position till enough of the earth around it is put about its roots to support it for a time, but no more. This should be done to each plant, observing to put only one row along the middle of each bed, and to keep the plants 4 feet apart from each other in the line, and to arrange each kind on the same bed or beds continuously till it is all planted, simultaneously with the operation of setting the plants in their places along the beds, as just described; other men follow taking more earth out of the alleys, and laying it on the adjoining beds, all so as to secure the roots of the trees now standing on them being properly covered with and planted in it. As the earth is thus taken out of the alleys, it should be carefully broken and levelled about the roots of the young trees, so as to secure their being planted to a proper depth, and in a satisfactory way in all respects. And while the work of removing the earth from the alleys and adding it to the beds goes on, attention should be paid to give the sides of both a uniform slope, as the nature of the soil may require, in order to prevent their falling down into the bottoms of the alleys after the work is finished.

391. The alleys will now act as drains to the beds, but as water would lodge in them after rains, provision should be made to obviate this by cutting an open ditch along one of the ends of the beds, into which all the alleys should run, and this should be carried out from the nursery to empty its water into some other ditch or conduit.

392. The young trees planted in the way described, they should be attended to and kept clear of weeds at all times by the frequent use of the hoe in summer. And in order to promote their growth as much as possible, they should have a slight manuring of old and well-rotted, not rich, manure, or well-decayed vegetable mould, every autumn or spring, which should be dug in—very shallowly, however, in order not to disturb the young roots of the plants. And besides, they should be attended to in respect to shortening any branches seeming to grow unduly strong, and to maintaining only one top or leader on each specimen.

393. If the trees are dealt with in this way, they will grow up rapidly, and very soon attain a height of stem and breadth of top

which will warrant their being planted out with the view of their producing immediate effect. The object of planting and rearing them in this way is to gain a few years, as compared with the time they would require to attain the same height if they were planted out in the field at once in the places they were to occupy. In short, by the mode recommended, the trees will be, say, 12 feet high, in half the time they would have taken to attain this height had they been put out on the field at once.

394. We have still to refer to the very great advantages gained by planting those young trees on ridges in the nursery, instead of in the level ground in the usual way. In the beds, the roots of the plants are all kept within the breadth of about 3 feet, and are not allowed to spread out where they cannot afterwards be secured for safe transplanting, as is the case with plants inserted in the surface in the usual way; and therefore by this mode of culture we have a security for all the roots of every plant being carried with them when they come to be removed, and this is of great importance for perfect success in transplanting. Besides, from the roots of the plants being confined within a given breadth, they rise more to the surface than in the case of the roots of plants placed in the ground in the usual way; and in consequence they get all the advantages of food, air, and sun in a greater degree, which results in a much more rapid growth. And still further, when the time for transplanting arrives, the plants are in all respects fully and perfectly prepared for the operation being successfully performed, inasmuch as, by whatever mode this is done, the plants can be removed with perfect balls, by simply placing the machine at the end of a line of the plants and slackening the roots of each one on the sides of the bed, when the whole mass in connection with it can be removed entire without any excavating whatever, and placed in the pit previously prepared for it. In short, plants treated in this way cannot fail to grow, and therefore it is that we recommend this mode of culture for all purposes for which plants of large size are wanted, even for hedgerow trees.

395. In planting out on their permanent sites trees of the description under notice, the first point to attend to is to make sure that the field is in all respects of a dry character of soil, as, if it is not so, disappointment may be the result. Of course, if it be not naturally dry, it should be made so by a system of thorough drainage previous to the planting being undertaken on it. The field made dry, the holes for the trees should be made about 4 inches deeper than the thickness of their balls, and about 2 feet wider in diameter, in order to admit of a sufficient quantity of prepared earth being put into each about the roots. As each hole is made for a tree, about three

wheelbarrow-loads of previously prepared earth—say good, light, turf loam, containing a quarter of its bulk of well-rotted vegetable mould, or common manure of the same character—should be laid down on the outside of it, keeping this clear of the soil taken out of it. The hole for a tree being made ready for it in this way, a quantity of the prepared earth should be next thrown into the bottom, say to the depth of 3 inches over all; and on this the ball of the tree should be placed, observing that it is not too deep, nor too high, but with its top part, at the bottom of the stem, about 2 inches under the level of the land around. These points attended to, and the tree placed properly upright, what remains of the prepared earth should now be put carefully to the ball all round, observing to put it under the ball where any hollowness appears, and to cover it in such a way that every part of it and its roots may have a covering of 3 inches of the fine earth; and this done, the whole may be filled with the soil previously taken out of it, taking care to break it finely, and to apply it regularly as it is put in, and not to displace any of the finer earth now lying on the ball.

396. As each tree is planted it should have a liberal watering about its roots, so as to settle the earth well about them, but no tramping of the earth should be made till two or three days after planting, when it can be made firm and level in the usual way, and supports put to such of the subjects as may require them.

CHAPTER IV.

SECTION I.—MANAGEMENT OF THE DIFFERENT SORTS OF HEDGE FENCES.

397. There is no fence more generally in use in the cultivated districts of Britain than the thorn hedge; and considering its permanent nature as a fence upon good land, it is certainly the best adapted for most purposes where a neat and clothed appearance is the object. The hedge is very much improved by having one-third of beech plants mixed among the thorns in planting, and this more particularly upon high situations with a light soil. There the thorns are very apt to die early; but when mixed with a proportion of beech plants, which thrive well in a light soil, the fence is much improved both in health and appearance. The soil upon which we have found the thorn thrive best as a hedge fence, and in which it is likely to live to a great age, is a heavy loam upon a dry bottom. In all light soils, such as moss, sand, or gravel, thorns are very apt to die suddenly; and therefore on land of these characters beech should always be planted as hedges, and not thorn.

398. Many recommend the practice of manuring poor light soils, for the reception of thorn plants, in the forming of a hedge fence; but this we can by no means approve of; and we mention this circumstance in order to put the inexperienced upon their guard. We have often had occasion to observe, that those hedges which were planted with manure in a naturally light poor soil, and upon a high situation, did indeed grow freely for the first two or three years after planting; but as soon as the manure had lost its effects upon the plants, they fell into a state of bad health; and in the course of five years from the time of planting, such a hedge was much inferior to others which had received no manure upon the same soil and situation. The best manure for thorns in a light soil is a good dressing of clay or heavy loam, if it can possibly be had; and if that cannot be got, plant beech instead of them in the natural soil, as this plant

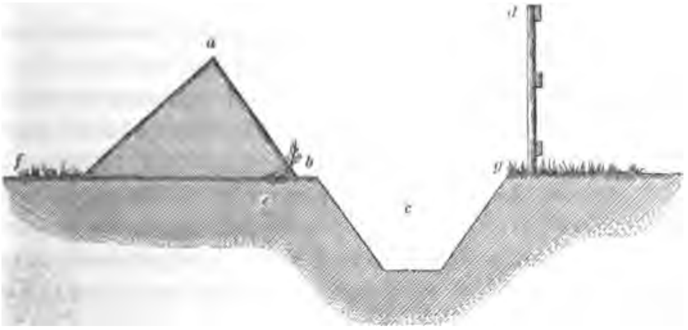
will be sure to succeed if attention be paid to keeping clean in summer, and cutting in autumn or spring.

399. As the thorn is a plant better suited for hedges in agricultural districts in this country than beech or any other plant we are yet acquainted with, where the soil is at all suitable to it, it should be planted alone, and without any intermixture whatever. This may be done on any description of land varying from a light loam to a clay, but not upon land that may be termed lighter than the former. If much lighter, or approaching to sandy loam, a mixture of beech should be used with the thorn; and if sand or gravel, beech alone should be used.

400. In the planting of thorn and beech hedges, two methods are practised, according as the soil may be damp or dry. The one method is that of planting the hedge on the brow of an open ditch, made at the same time for the purpose of keeping the roots of the hedge dry and for collecting and carrying off water from the field or plantation which it surrounds. The other method is that of planting the hedge upon the surface of the soil without any ditch whatever: and either of these methods may be adopted according to circumstances; although, for our own part, we are decidedly in favour of the latter method, as being the most neat and least expensive in executing, as well as taking up much less room in the field; and where the soil is rendered dry it thrives better.

Fig. 5 is a section of a hedge planted upon the brow of a ditch; and by referring to it, the method of planting the same will be easily understood.

Fig. 5.



401. In executing the work of planting a hedge of the description shown in the above figure, the operator first stretches his line along the run of the ground where the hedge is to be planted, and which it is understood has been previously set off by pins driven into the ground; but instead of placing the line in the exact run of where the

hedge is to be planted, the operator pins it down about 6 inches to that side of the run upon which the open ditch is to be made. He next proceeds to level and clean from all weeds, &c., with the common spade which is used in doing this work, the surface of the ground all along upon the run or hedge-line, as far as his line has been stretched, to the breadth of about 24 inches back from his line; and having done this, in a manner to correspond with the rising or falling of the ground in the run of the hedge, observing to level up or reduce any sudden inequality, he next proceeds to mark off carefully the edge of the ditch upon which his line was first stretched; and in doing this, the operator turns his face to the side where the ditch is to be, and with his foot he forces the spade pretty deeply into the ground, cutting the surface exactly all along by the line; but he must observe not to cut perpendicularly with the spade, but to cut with a considerable slope to the ditch, in order to form part of its side, as may be seen by glancing at fig. 5, where *b* represents the point upon which the line rests, with the slope of the ditch under; and when he has finished the cutting of the one side as directed, he will lift his line 4 feet to the opposite side, in order to form the other side of the ditch, as at *g*, observing to make the second cut exactly parallel with the first; and in the act of cutting he must turn his face again to the ditch, in order to form the opposite slope. Both sides of the ditch being marked off, the operator with his spade next raises the turf, or whatever the surface may be, but which should be always cleaned from weeds, the outer edge of which he first marked off at *b*; and, lifting it up, he turns it upside down upon the part which he formerly levelled for the planting of the hedge, which part is now termed the *bed*, as at *e*, upon which the roots of the young plants are to be laid; and in doing this part of the work, 6 inches of the level part must be left between the side of the bed and the edge of the ditch, which is termed the *scarcement*, and is meant to support the bed firmly, as well as to prevent the rolling down of loose earth from the bank *a* into the ditch *c*; therefore the operator, in lifting the soil from the edge of the ditch in order to make up the plant bed, must keep it regularly 6 inches back from the edge; and in preparing the bed for the reception of the roots of the young plants, it must be made 3 inches above the level part or scarcement, upon the outside, and this in a compact level manner, and must slope backwards from the outer edge at an angle of about 45 degrees. (See fig. at *e*.) And this in order that the roots of the plants may not be flat, but dip into the earth, and that their tops may incline considerably upwards.

The bed and scarcement being finished, as has been directed above, and made perfectly clean from weeds, the next part of the work is to have the plants prepared for putting in; and as it is presumed that the plants—say thorn and beech—have been brought forward in due time and put into the earth by the roots in a dry part near the work, the operator will bring them forward, and before putting them into their bed, he will, with a pruning-knife, and not with an axe, as many carelessly do, cut every thorn plant down to within about 4 inches of the top of the root—or, in other words, leaving only 4 inches of the stem of each plant. But with regard to the beech plants, if any are to be planted among the thorns, they must not be cut at all, not even the tops—for they do not succeed well if cut at this stage; and beech plants for this purpose may be from 8 to 12 inches high. Having the plants thus prepared, the principal operator will take a few plants, both of thorn and beech, in his left hand, and with his right he will lay the plants upon the slope or bed prepared for them, putting in successively 2 thorns and 1 beech, at the distance of about 10 inches, plant from plant. In laying the plants upon the bed, the top or cut part of the thorn may be made to project over the outer edge of the bed about 2 inches, which part will set away young shoots to form the hedge; but the beech must be allowed to have all their top part lying out, with their roots upon the same level with those of the thorns.

As the principal operator or workman proceeds in thus laying out the plants upon their bed, another careful person follows him, and collecting the finest of the soil from the part of the ditch opened in making the bed, he puts it upon the roots of the plants, covering them very carefully, and using caution in order not to displace any of the plants while lying in their uncovered state; a third man follows, who puts on another spadeful of earth from the surface of the ditch all along upon that put on by the second man, which second spadeful will be enough to cover the roots securely; and when this is finished, the whole of the soil thus put upon the roots of the plants should get a slight tramping with the feet, in order to make the plants secure in their place, and exclude the drought from the roots. This being done the whole length of the line, the whole of the earth contained in the ditch *c* is then thrown out and made to form the bank above the roots of the plants, in the shape as seen in the figure at *a*. The ditch is generally made 4 feet wide at top, and 15 inches at bottom, and 2 feet deep; and the size of the newly formed bank, which is made from the earth taken out of the ditch, will be nearly 2½ feet deep at the point above the plants at *a*, and from 4 to 4½ feet wide at the base. After the earth has been all thrown out of the ditch, and it is properly formed, smooth upon each side and level in the bottom, the bank should next be formed to nearly the same slope as the edge of the ditch under it; but as it is formed of loose earth, it is better to keep the slope of the bank a little flatter than that of the ditch under; and in order to prevent any of the loose earth tumbling into the ditch from the bank, it should be tramped and made firm as the work proceeds. And when the whole is finished, it should receive a firm clapping by means of the back of the spades, which keeps it all firm and smooth above.

In the finishing, the level scarcement ought to be left in a clean and neat manner, without any roughness lying upon it; and the tops of the thorns should all project regularly, and the soil be made firm about their necks. In this manner the whole line of hedge is to be done, one line-length after another; and when the whole is finished, a paling ought to be put up on the outside of the ditch, in order to protect the young hedge from the inroads of cattle. The paling, when put up, will require to be kept good until such time as the hedge becomes a proper fence of itself, which, upon an average, may not be till it has grown seven or eight years.

The method of growing hedges, as has been directed above, is excellently adapted to land of a wet character, or rather where the draining of the land has not been attended to; for no thorn hedge will succeed unless the ground upon which it is planted be rendered dry; therefore, if the ground where a hedge fence is to be planted is either not naturally dry or not made so by artificial drainage, the plan as above detailed must be resorted to. Besides, it often happens that in the laying out of ground for a new plantation, the drains in it require to be run into some large ditch, in order to act as an outlet for the water; and in this case the system of fencing with a ditch answers well—that is to say, all other circumstances corresponding; and in such a case, the ditch requires to be placed next the wood, with the hedge and bank outside, with the paling upon the outer tail of the bank, as at *f* in fig. 5.

402. We shall now refer to the other method of planting hedges—namely, that of planting in the surface-soil without any ditch whatever. In all cases where the land is either naturally dry or has been rendered so by artificial drainage, and where there is at the same time no necessity for any ditch as an outlet for water from drains, &c., made in the neighbourhood, whether that may be in the case of an adjoining field or a plantation, we would advise not to plant hedges in the form of ridge and ditch, but simply in the common soil of the line of fence required. In planting a hedge in this manner, we have the ground trenched in the line of the hedge to be planted, 4 feet wide by 24 inches deep; and in the act of digging, we have all root-weeds carefully picked out, which ought to be particularly attended to in the planting of all hedges, seeing that the eradicating of such afterwards has a tendency to disturb the roots of the plants too much, and check their growth by admitting too

much drought. When the whole length of the ground for the intended hedge has been thus prepared by trenching and cleaning, we have it very nicely levelled by the eye in the first place; and when we consider the ground to be nearly as level as we wish it, we next place the line along the middle of the ground, stretching it pretty tightly, in order that it may tell the level by its tightness—for where the ground is hollow the line will be above it; and where the ground is high the line will be lying too close upon that part. And having the line thus tightly set, we go upon it with our feet, keeping it right under the middle of the soles of our shoes; and in this position we tread the earth firmly, walking sideways all along the length of the line; by doing this we have the soil firm about 5 inches upon each side of the line. Coming off at the end of the line, which we allow to remain, we make up with fresh soil, from one side of the line, any inequalities caused by the feet in walking along, and beat the new surface with the back of the spade as we proceed, keeping about 7 or 8 inches in breadth level on the one side of the line, and only about 2 or 3 upon the other. This being done, we next take out an opening with the spade upon that side of the line which has the least level ground upon it, and this opening we make about 9 or 10 inches deep, according as the roots of the plants may require, taking care to have the opening neatly cut by the run of the line. We next have the plants prepared as formerly stated, and put them in along the side of the firm level edge, observing to keep the stalks of the thorns about 2 inches above the surface, and the beech plants all the height, as formerly stated; then fill in the earth and make the whole firm and level, which concludes the work of planting the hedge.

403. In comparing the two methods of planting hedges just described, we have found that by the last-mentioned system the plants come much sooner to useful size than when planted on the edge of a ditch; and therefore we now employ it chiefly. There is another and a very important benefit attending this mode of planting hedges without a ditch, which gives it great advantage in an economical point of view, as compared with the other—namely, the taking up of very little ground in the subdividing of land; for it must be observed that where there is a hedge and ditch much useful land is occupied, but where there is no ditch the least possible quantity of land is taken up by the fence. In choosing or refusing the one or the other, much depends upon the circumstances to be overcome, which must all be taken into consideration. Upon several estates with which we have had to do, where most of the hedge fences had been reared upon the ditch system, we have put drain-tiles into the ditches and filled them up, in order to improve the fences, which had become stunted and unhealthy from neglect. By this many of these hedges, which were

formerly in an unsatisfactory condition, are much improved, as they have been so much benefited by the additional supply of new soil about their roots; and on the whole this scheme promises to be of great advantage in the renewal of such old hedges as have been planted on the sides of ditches.

404. In all cases of preparing soil for the reception of plants intended for a hedge, good earth should be added where it is naturally poor and bad upon the line, as, if this should not be attended to, the hedge will come away unequally—that is, strongly where the land is naturally strong and good, and weakly where it is poor and bad. Where it is found necessary to improve the natural ground on the line of a new hedge, this cannot be better accomplished than by carting fresh and good loam from a distance, and adding it in considerable quantities to the natural portion, and of course mixing them well together.

405. Lime is sometimes applied to the bed of a young hedge; and in moderate quantities on strong land, and on land having much vegetable matter in it, it has a good effect in causing the plants to grow quickly; but, further than this, no manure should be applied, as good fresh soil, applied with perhaps a mixture of lime, is always more conducive to the health of the plants than any species of vegetable manure.

406. We have found, from our more extended experience in the rearing of hedges, that the plants used should never be planted closer to one another in the line than 10 inches, nor farther apart than 12 inches. We state this from finding that plants put in much closer than the former distance grow up weakly, and soon become matured; and that when put in at a greater distance than the latter, they are long in filling up so as to become a fence. We are of opinion, therefore, that from 10 to 12 inches apart is a very suitable distance for plants growing healthily in a hedge, and for their becoming so strong as to resist cattle, which is the object in view.

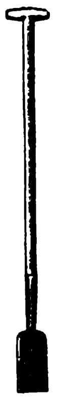
407. The best time of the year for planting hedges, whether thorn or beech, is the month of November, or that of February. In either case, the ground should be properly prepared some months previously, in order that it may have time to ameliorate and subside, as any subsiding should be made up before planting, otherwise the line will look badly.

408. We now come to speak of the after-management of the hedge fence, which is a matter of the very greatest importance to the welfare of such fences, seeing that many of them die from the want of due care being bestowed upon them; and, as we have already said, the great points in their management are regular cutting and cleaning. Supposing that a young hedge has been planted any time between the

first of November and the end of February, it will, during the following summer, make considerable shoots. The thorns will, in all probability, have made shoots of 12 inches at an average; but if beech plants are used, they will have made comparatively little progress, because they naturally require a longer period to establish themselves in the soil. If, however, they have appeared fresh in the leaf, and only made from 2 to 3 inches of young wood upon the top shoots, it is quite satisfactory; and indeed, had the thorn plant not been cut down, they very possibly would not have made a greater growth than the beech; and had the beech been cut down in the same manner as the thorns, it is very possible that the half of them would have died. This explains the reason for cutting the one and not the other—that is, the growth of the thorn plant is encouraged by severe cutting, while that of the beech in its young state is the reverse, particularly as regards the old wood.

409. We are aware that many foresters are in the habit of cutting over in autumn the shoots of the first year in young thorn hedges; but to this practice we beg to object, because we have found, from observation and experience, that it is an error. We, in all cases of hedge-culture, allow the plants to remain uncut until they have two years' wood upon them, and until they have had their roots thoroughly established; and when they have arrived at this stage, we cut the plants over to about 9 inches high, and dress in the sides also pretty closely, say in the month of November. During the first two summers, therefore, after the hedge has been first planted, all the attention necessary to be bestowed upon it is that of keeping it clear of weeds, which is simply done with a small spade, termed the hedge-cleaner (fig. 6); this is about 4 feet in length, including the handle, and the spade itself is 5 inches broad, by about 9 inches long, excluding the hose, which is about the same length as the spade. This spade is kept pretty sharp upon the edge, and is wrought much in the same manner as a gardener does a Dutch hoe. Indeed many use a small Dutch hoe instead, which answers the purpose very well. A common rake should be used to clear the weeds after the hoe, where this is considered necessary. The hedges should be cleaned twice in the season—namely, in the months of June and August.

Fig. 6.



410. In the training up of a hedge, where the object is that of having a firm and compact fence, capable of resisting the ordinary efforts of cattle of any description, the only mode is that of keeping the ground immediately under the hedge plants clean from all weeds, as this secures the health of the hedge in the under part, and allows it to spread down to the very ground; whereas, when weeds are allowed to grow under the hedge, it soon becomes bare and naked of

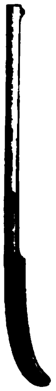
branches, and proves open and weak there. In the cleaning of hedge fences, it is also an object of great importance to keep the ground clear of weeds at least one foot beyond the *drip* on each side; for this secures a free current of air passing through, without which a hedge fence is sure to become bare and weakly below. This cleaning, once the ground has been a few years regularly kept, may be done for one halfpenny a rood per year throughout the whole period; but if the hedges have been allowed to become dirty from the want of attention, and if they have not been cleaned for several years, as is too often the case, they may cost four or five pence a rood to put them in order, even for one cleaning, besides the injury done to the fence. These observations we make here in order to point out the great necessity and propriety of keeping all hedge fences clean; for although it may indeed cost a proprietor a few pounds each year to do so, still, if the work be neglected for three or four years, a much larger sum is eventually required to put them right, independent of in a great measure ruining his fences.

411. Having said this much as to keeping clean all hedge fences, we in the next place have to say, that in the training up of a hedge, where the object is that of having a firm and compact fence capable of resisting cattle, the great point is, after that of keeping clean, to cut the fence yearly according to a given form; and this form must in all cases be regulated by the situation in which the fence grows, by the object in view, and in a great measure by the taste of the proprietor. In order to illustrate our meaning more fully, we shall make a few remarks upon each of these points. We said that it is necessary to cut hedge fences yearly; and we believe that there are very few practical foresters who will not agree with us upon this point; for every one who has had his attention directed to the rearing of such fences, at once sees the difference between a hedge not cut yearly and one that is. In the first case, the hedge soon begins to get bare at bottom and over-bushy at top; besides, it very soon becomes loose and open, and without firmness or compactness to resist as a fence ought to do. In the latter case, the hedge, from being regularly cut, is kept close in texture from bottom to top, and is healthy and long-lived as compared with one not regularly cut.

412. In cutting young hedges and training them up to maturity, we allow the plants to remain uncut till the end of the second year, when, for the first time, we cut them over about 9 inches from the surface, and at the same time we cut in the sides pretty closely also, using for the purpose what is termed the hedger's switching-bill (see fig. 7), and never the shears, as some do in cutting young hedges. The shears, in all cases where they are used for cutting a hedge, make a rough wound, which is generally attended with the loss of a

bud or two under the wound; but the switching-bill, on the contrary, makes a clean cut, and no bad consequences follow. Besides, a hedge that is cut by using the bill is in all cases trained up more closely and firmly than one cut with the shears. In cutting a hedge for the second time, which will be when it is 3 years old, we cut it down to about 15 inches in height, making it regular on the top level; and in the side cutting we leave only about 2 inches of a spur of the last year's growth. This we continue to do each year successively until we have the fence of full size—that is, in each successive cutting that we give a young thorn-hedge annually, we leave it from 4 to 6 inches higher, as the strength of the plants may indicate, and at least 2 inches broader on each side than it was the previous year, until we have it 4½ feet high, after which period we keep it down each following year as nearly to the old height as possible. For every forester must be aware that, in cutting hedges, they will increase in height and breadth of their own accord under the best system of cutting, seeing that, in the act of cutting off the annual shoots, there is always a short piece left, called a spur, at the base of every young shoot cut. So much, indeed, does this increase the bulk of the best-kept hedges, that in course of time it is found necessary to reduce them in bulk, and to allow them to come away anew again, which yet remains to be explained. A hedge, in the course of a number of years, however well kept, generally outgrows itself, from the cause above stated; and this state of a hedge is easily known by its becoming loose in habit, and of an open overgrown appearance. Now there is no way of renewing a hedge in this state but that of cutting it in, or what is termed *ribbing;* and this ribbing consists in stripping the hedge of its side branches, and allowing it to make new wood all over. But in doing this caution must be used; for we have more than once seen, where hedges had been ribbed without due caution, that they died down to the surface, and consequently had to be cut over at that part, and allowed to grow up anew from the old roots. Therefore, in the ribbing of a hedge, the following points must be kept in view: When it is found necessary to *ribb* in a hedge, let it be considered whether or not the situation be an exposed one; and if the situation be not an exposed one, nor in a part of the country exposed to the sea, nor more than 600 feet above the level of the sea, the ribbing may be done from November to the first of April, as may best suit. In doing the work, the operator will use what is termed the *ribbing-bill,* which is much stronger and heavier than the switching-bill, and has less hook upon the point. In ribbing the hedge, the operator cuts off all the lateral branches *upwards,* to within about 4 inches of the main stems upon each side;

Fig. 7.



and the hedge over all should also be reduced in height to about 3 feet. It should also be kept in view, in the case of ribbing in a hedge, that if sheep or cattle are in the habit of grazing in the field adjoining, the ribbing should be done at a period when the field is under farm-crop, and when there is to be no stock grazing for a year or two after; for if it should be done at a period when sheep or other animals are in the field where the hedge is, they are sure to injure it by eating the young shoots as they grow; besides, their hair and grease are injurious to the welfare of a hedge so closely cut in. Again, where the situation of a hedge to be ribbed is much exposed, do not ribb it before the month of March or April, when any severe check from the effects of exposure is likely to be over for the season. From this rule not being observed, we have frequently seen hedges die down to the ground when they were ribbed in the winter season upon a high and exposed part.

413. There is also the renewing of old and neglected hedge fences to be taken into consideration. It very often happens that where hedge fences have been badly managed for a few years successively, they begin to die out by degrees: this is evidenced by many of the plants becoming stunted in appearance, and by gaps occurring here and there from deaths among the plants, and the more healthy of them becoming tall and spreading. This state of hedges may be accounted for in various ways: it may be caused by neglect of thorough drainage, and by neglect of keeping the plants clear of weeds; it may also be brought on from the natural soil not being well adapted to the healthy growth of the plants, from neglect of properly cutting the plants, and by allowing them to grow to such an extent as to exhaust the ground. In order to renew such a neglected hedge as has been described above, the plants require to be all cut down to within about 6 inches of the ground, observing to make the cuts upwards. When this is done, and the rubbish removed, the ground should be well cleaned, and dug to the extent of about 24 inches upon each side of the hedge-line, and all gaps among the old stumps made up with new or young plants. In making up with young plants among the roots of old thorns, we have to observe that young plants of the same sort should not be used in such cases, as they never succeed well where old thorns have been growing; but in all cases of this nature use beech plants, for they thrive well among old thorns. Work of this kind may be done during open weather any time during winter; and in order to have the hedge continue sound and prove a good fence afterwards, it must be kept clean, protected, and regularly cut, as has been already stated. The directions just given for the renewal of old and neglected hedges will be found to answer very well where the subjects are comparatively healthy, and

not too far destroyed by disease; but with regard to such old hedges as have been very much neglected, and are in consequence very much diseased, the mode we have recommended will not recover the plants so as to cause them to grow healthy and make a fence. Where, therefore, the plants forming a hedge are very much diseased from one or other of the causes stated, they should be dug out altogether, and a new hedge planted instead, and upon a new line of land, if possible; as to replant upon the old line, where the soil is exhausted, would be very injudicious. If, however, it should be found necessary to plant again upon the old line, the land must be rendered perfectly dry by drainage, if at all wet; afterwards the exhausted soil of the old line must be entirely removed, to the extent of 5 feet broad and 2 feet deep. Into this good soil should be put from an adjoining field, and the young hedge planted in it in the usual way. No other mode will secure a thriving fence under such circumstances.

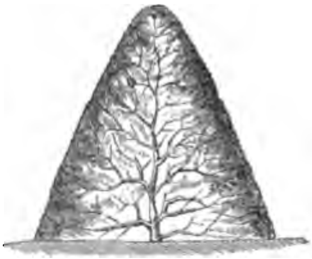
414. We now come to consider the form in which hedge fences should be trained up; and, as we have already said, this form must be regulated by the situation in which the fence grows, by the object in view, and in a great measure by the taste of the proprietor.

415. There are four forms of hedge fences as generally adopted in different districts of Britain—namely, the wedge-shaped, the full-sided, the square-shaped, and the upright. The form of each of these will be better understood by referring to figs. 8, 9, 10, and 11, which represent an end section of each of the four different forms mentioned.

A few remarks upon each of these forms of hedges will be enough under the present head.

416. The wedge-shaped thorn-hedge, an end section of which is represented by fig. 8, is of all others the best form for a high-lying district where snow is apt to prevail; and it is, moreover, the form which is by far the simplest to keep in order in the way of cutting. In high-lying parts of the country, hedges are often much injured by heavy falls of snow falling upon them; and in a case of this nature the wedge form is the best that can be adopted, seeing that much perpendicular pressure cannot lie upon any part of it. It is this shape of a hedge that prevails upon all the high-lying agricultural districts of both England and Scotland.

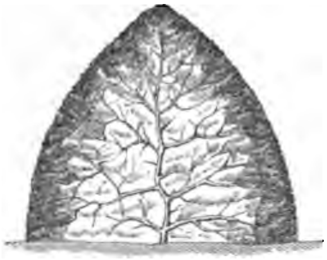
Fig. 8.



417. The full-sided thorn-hedge, an end section of which is represented by fig. 9, is the most common form to be found in all well-sheltered agricultural districts, for which it is very well adapted—for, by its

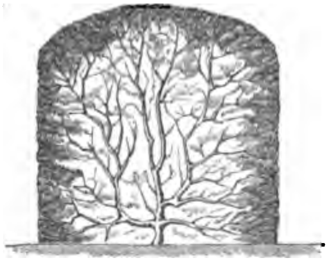
bulging sides, it is not easily approached too close or injured by stock of any kind; but it is very apt to go out of order, and to overgrow itself, if not under skilful and good management. Excellent specimens of this form of hedge are to be seen in the Lothians of Scotland, and in the best-cultivated districts of the central counties of England, where the soil is well adapted for its healthy development. It is not, however, adapted for a high-lying country where snow is apt to prevail, for its bulging sides are very apt to be crushed and broken by the weight of snow lying upon it; and this we have had frequent proof of in many high-lying parts of Scotland.

Fig. 9.



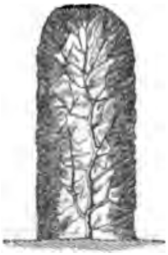
418. The square-shaped hedge, an end section of which is represented by fig. 10, is solely adapted for home or policy grounds, and ought never to be introduced either as a wood or a field fence; and we merely advert to it in order to point out its impropriety for general use. It is all very well to have a fence of this kind round a garden, where it may be well kept; but as a general country fence, it is the most liable of all to become overgrown and useless.

Fig. 10.



419. The upright hedge (fig. 11) is an admirable fence, and is well adapted for pleasure-ground scenery, or about home parks, but not at all for a farm or field fence. Now we think it is plain, from all we have said, that in choosing the form of a hedge, it is always of the first importance to consult what is most useful rather than that which is most ornamental. It would be foolish to rear up a hedge in the square form upon a high-lying district, merely for the sake of gratifying the taste, when it is well known that such a form would not answer. In short, such a state of things would be bad taste; yet it is very often to be observed. For our own part, we consider the wedge-shaped and the full-sided forms the best that can be adopted for usefulness; and the other two we consider merely as ornamental forms, but well adapted for the producing of extra shelter upon home grounds.

Fig. 11.

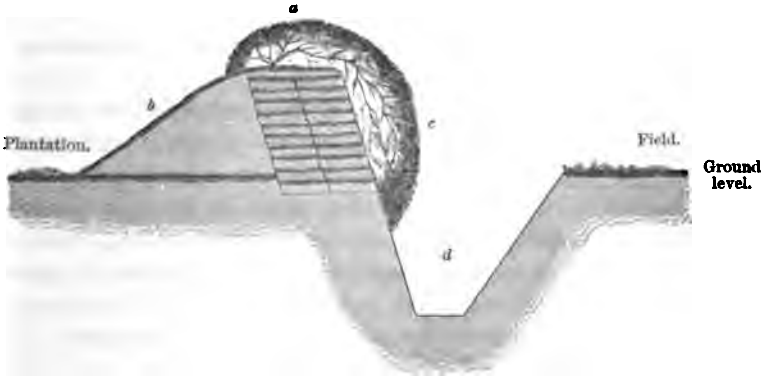


420. *The whin or furze hedge* (*Ulex Europœus*) is one which pre-

vails much in many parts of the north of Scotland and in Ireland as a plantation fence; but it does not, in our opinion, make a fence worthy of being recommended, seeing that the furze is extremely apt to be injured by a winter of severe frost; and, in their best condition, the furze hedges form such harbours for rabbits that they are extremely objectionable as a fence for young plantations. We do not know of any case in which furze hedges have been planted where a properly managed hedge of beech would not do much better in every sense of the word, it being longer-lived and more ornamental.

By referring to fig. 12, the method of rearing furze hedges, as generally practised in Scotland and Ireland, will be easily understood:

Fig. 12.



d is an open ditch, about 4 feet wide at top, and sloped in to about 1 foot wide at bottom. It will also be observed that the slope of the ditch upon the field side is more flat than that of the plantation side, and this is in order to make the plantation side of the ditch act better as a fence. The ditch is made about 3 feet deep from the ground level, and the turf, as taken from the surface of the ground in making the ditch, is built upon the plantation side to about the height of other 2 feet above the surface, making the fence altogether, from the bottom of the ditch, 5 feet high. In order to make the turf-built part of the fence secure, it is made about 2 feet thick, with the same slope backwards as the side of the ditch under, and founded firmly upon the surface. The earth, as taken from the ditch, is banked firmly behind and a little over the top of the turf, in order to form a bed for the sowing of the furze, as at *b*. The whole being finished, the seed of the furze is sown in a line along the top of the bank, as at *a*, about 18 inches back from the upper edge of the fence.

When the young plants appear above ground, the seed being sown in April, they are kept clean during the first and second years, and thinned when too thick; and the third summer, when they have become pretty strong, they receive a dressing with the switching-bill. In doing this, they are cut in the direction of the field—that is to say, the bill is entered at the back or plantation side of the furze, and brought forward, cutting towards the ditch, or downwards; and by this means the young shoots are made to grow out in that direction, presenting all their points to the field, and consequently forming the best position for a fence. These hedges ought never to be cut at any time of the year but when they have newly shed their flowers, which is about the middle of June; for it is then that they form their young wood, and are consequently most improved by cutting. We have seen many hedges of this sort die from being cut in spring or autumn; consequently they ought never to be cut but in the beginning of their growing season. In the training of such hedges, they are made to lie over the slope, as at *c*, and not allowed to spread much back into the wood.

421. THE HOLLY HEDGE—that is, the hedge formed of the common holly (*Ilex aquifolium*)—makes an excellent and ornamental fence where only required as a screen to hide some part of the grounds from view, or where shelter alone is wanted; but from the nature of the plant it is not adapted to form a strong fence against cattle in fields. One advantage of the holly is, that it grows well under the shade of trees, and from this it is fitted to make a hedge on many situations where few other plants would succeed. To grow it well, however, it requires to be planted on a good dry light loam, having an abundance of vegetable matter in it. We have never yet found the holly succeed luxuriantly in a soil destitute of a large amount of old and well-decomposed vegetable matter, such as a sandy moss or a soil chiefly composed of well-rotted leaf-mould. In planting a hedge of this plant, therefore, this should be kept in view; as, if not, failure will be the result.

422. THE COMMON PORTUGAL LAUREL (*Cerasus lusitanica*) makes also a very ornamental evergreen hedge, but is suitable in this respect only in such situations as are not exposed. Being a native of the continent of Europe, it does not thrive without shelter, and is therefore not adapted to make a fence in fields. It is, however, not particular as to soil, but seems to accommodate itself to most soils, provided it be sheltered from cutting winds.

423. THE COMMON YEW-TREE (*Taxus baccata*) is also well suited for ornamental hedging, but, other than this, it is worthless, not only on account of its naturally slow growth, but also because its habit is of too soft a character to resist large animals. Another objection to its being grown where cattle graze is, that its leaves are believed to be poisonous to them.

424. THE BOX-TREE (*Buxus sempervirens*) is another plant well adapted to ornamental hedging, but is of no advantage for field or other fences.

425. THE PRIVET (*Ligustrum vulgare*) is a plant of rapid growth, and well suited in some respects for hedging. It is not a plant suited to make a strong fence as a hedge of itself, as it is not only of too soft and pliable a nature to resist pressure, but it is also of such a free and rambling growth that it is very difficult to keep it in any degree of tidiness or shape. We like this plant very well, however, for the purpose of filling up gaps in old hedges of thorn, in which it is sometimes very difficult to get any other plant to grow, so as to fill up a spot where an old thorn plant had died. We recommend the privet, therefore, for this purpose. In using them, it is only necessary to dig out the old roots of the dead thorn plants, and insert young ones of the privet instead, say at 6 inches apart. We have seen small gaps in old hedges excellently repaired in this way; and as the naturally rapid growth of the privet is promoted by the shelter and support of the old hedge, gaps may be filled up by it in a complete way, even in two years after planting.

426. BERBERRY (*Berberis vulgaris*) is another plant frequently used for hedging, but as it is very apt to die under severe pruning, which is indispensable in hedge-culture, it does not generally answer well.

427. HORNBEAM (*Carpinus betulus*) is a plant well suited to hedging. Indeed in this respect it is only surpassed by the thorn and the beech among all the hedge plants we have. We have seen excellent hedges of this plant on a light sandy soil, on which thorns would not succeed. The plant attains a third-rate tree size, and therefore forms a strong and permanent fence as a hedge when dealt with in the common way.

428. THE BIRCH (*Betula alba*) is well suited for hedging on poor thin soils having a high altitude. It stands pruning well, and when properly trained and kept in, it makes a fair and permanent fence.

429. THE ELDER (*Sambucus nigra*) is much used for hedging in the north of Scotland, but its hardiness and quick growth are its only recommendative qualities, as it is ill adapted to produce shelter in winter and spring. We are of opinion that, as a hedge plant, even for high and exposed situations with a poor soil, the beech and the birch are much preferable to the elder. When a screen is quickly wanted, however, on an exposed part, it is certainly preferable to any plant we have for the purpose, as it will generally make a growth of from 4 to 6 feet in one season.

430. THE MYROBELLA, or CHERRY PLUM (*Prunus myrobalana*), is said to be an excellent plant for making hedges. It grows well on

very poor soils, and stands cutting as well as the thorn. It is said to stand well within the influence of the sea breezes. We have not, however, as yet had any experience of its fitness as a hedge plant, but as it is highly recommended for this purpose we note it here, in order that its merits may be tested by foresters who may be inclined to give it a trial.

431. In rearing hedges from the plants referred to under the ten paragraphs immediately preceding this one, they should have the land prepared for them in the way recommended for the cultivation of the thorn and beech hedges; and in planting them in the lines, no pruning should be allowed on the holly, the Portugal laurel, the yew-tree, the box-tree, the berberry, the hornbeam, and the birch. They should also be allowed to stand uncut for a period of two years after planting, and until they shall have become properly established in the soil, when they may be dealt with in the usual way. But plants of the privet, elder, and cherry plum, when used for hedging, should be cut over at first in the way recommended in respect to the thorn, and should also be pruned well in every year afterwards.

432. In the cultivation of all hedge fences, as little digging should be allowed as possible, as the operation invariably disturbs and destroys the roots; and where the roots are destroyed by such injudicious management as the practice of frequent digging is, the hedge plants become of weakly constitution, gradually lose their vitality, and consequently die. The only digging we should allow in the management of hedges would be in the case of such as had to be cut over, and such as had been neglected in cleaning for some years. In such cases, digging in order to attain cleanness is indispensable. Where hedges are well kept, it is never found necessary to *dig*, but to hoe only.

433. Hedges formed of *deciduous* plants should never be pruned till the young shoots of the season are matured, as, if they should be cut before this, the plants suffer in health in consequence. This point is generally too little attended to, and hence one of the causes of disease in regard to a very large extent of the hedges of this country. In the economy of a plant, the roots draw up food from the soil, and the leaves prepare it for the healthy growth of all its parts. If this is the case, then, and it is admitted to be so by all physiologists, how can deciduous hedges grow healthily that are annually dug instead of cleaned, and switched in summer, while their young shoots are only being developed? We condemn, in the strongest possible terms, all such management of this class of hedges, and recommend, instead of such barbarous operations, to use the hoe only in cleaning, as a proper use of it will not injure the roots of hedge plants, and that no switching or pruning should be done till

after the leaves shall have performed their functions in the economy of the plant, and this may at any time be known by the leaves falling off, as at this stage it is evident they have ceased to be of use to the plant.

434. The pruning of hedges formed from evergreen plants, we are of opinion, should be done just when they begin to grow. This may, of course, vary with the nature of the season, and with the respective kind of plant of which the hedge may be formed; but we think that we are correct in stating that, generally speaking, the month of April may be taken as a safe time for the pruning of all evergreens.

435. If hedges are well attended to while young, they are not so expensive to maintain afterwards as many imagine. It is neglect that principally gives rise to expense in connection with them. On well-managed estates in different parts of the country we have had hedges—well-kept ones—cleaned and pruned, and in every respect kept in good order, for one farthing per yard per annum, or at the rate of £1, 16s. 8d. per mile: this certainly cannot be considered expensive. But at the same time we have to add, that on other estates, where the hedges have been in bad keeping for some time previously, they have cost the proprietor nearly ten times this sum.

SECTION II.—THE BUILDING OF STONE-AND-LIME WALLS AS APPLIED TO MAKING SUNK FENCES.

436. Stone-and-lime walls are most frequently built for the purpose of policy-fences, or for sunk fences. As to the erecting of walls for the protecting of home or policy grounds, the dimensions of such must in all cases be regulated by the views of the proprietor—that is, if the proprietor merely wish to have a wall erected in order to protect his home grounds from the inroads of cattle, it may be built 16 inches thick at bottom, 12 inches at top immediately under the cope; the cope may be 10 inches high, pick-dressed, and project 2 inches over the building on each side; and the whole height of the wall may be made, including the cope, 5½ feet.

437. If the proprietor wish to have a stone-and-lime wall erected, sufficient to protect from the inroads of people who may be apt to transgress in the neighbourhood, as well as to retain deer that may be kept in the home parks, he would require to build it at least about 7 feet high; and a wall of this height would require to be 18 inches thick at bottom, and 15 inches at top of building immediately under the cope, which would require to be at least 12 inches high. A great point to attend to in the building of stone walls for fences is, to see that no soft or bad stones be used, particularly in the outer

part of the building—for if such be used, the wall is sure not to last long, nor give anything like permanent satisfaction; therefore the forester or land-steward who may be intrusted with the inspection of such work, should be most careful to see that this point is enforced upon the contractor. There is another point to be observed in the erecting of all stone walls, whether these may be built with lime or not—and that is, to see that all the stones used in the building be laid upon what is generally termed their natural bed; that is, the natural seams in the stones taken from stratified rocks should lie horizontally in the building, and not vertically.

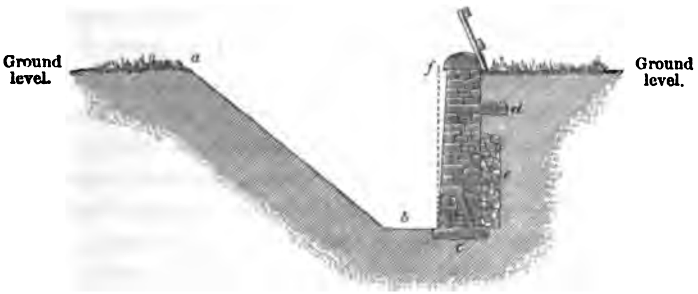
438. Having said this much as to the building of stone-and-lime walls as they are generally applied to the fencing of policy-grounds, we now come to treat of them as they are generally applied in the making of *sunk fences.* But previous to giving directions as to the manner of doing this sort of work, we will say a little as to the propriety or impropriety of making sunk fences.

The sunk fence is one which, from its very name, is meant to be hidden. It is a fence often to be met with upon noblemen's and gentlemen's estates of old standing, and was a hundred years ago very much introduced in the laying out of grounds and home parks; but now since wire fences have come to be so much used, the erecting of sunk fences is fast giving way, and they are very seldom introduced—excepting, indeed, where they may answer some particular purpose, as on the slope of a hill or brae, for which situation the sunk fence is admirably adapted, and is of all others the most fit and suitable. No doubt "taste is everything;" but, in our opinion, in the matter of fencing, that taste is always the most pleasing to all parties which can produce something light and airy, and of the most natural appearance, and at the same time at the least amount of expense. Now, in applying this to the erecting of sunk fences near or about home parks—where, indeed, taste should always be taken into consideration—we at once see that a sunk fence is, in regard to lightness, airy and natural appearance, much inferior to the wire fence, and is, at the same time, much more expensive in the first erection; therefore, in our opinion, sunk fences ought never to be made upon any level piece of ground, but instead, the wire-fence should be erected. But upon any steep sloping bank, where it is desirable to have a fence, we would recommend the sunk fence, with a low wire fence on the top, as a complete and answerable thing. As we are aware that many proprietors are much in favour of sunk fences as generally made, we shall here, in order to assist superintendents of such work, give a detail of the manner of erecting them.

They are made with a wall upon one side and a paling fence upon the top. The construction of these will be better understood by referring to the following figures.

Fig. 13 is an end section of an angular sunk fence, as often met with in the home grounds of old seats. The distance from *a* to *f* is generally 8 feet, being the surface of the opening or ditch; the height of the wall, including the cope, from *f* to *b*, is generally about 5 feet 6 inches; and the breadth of the ditch at *b*, being the bottom, is generally from 18 to 24 inches. But in the act of excavating a sunk fence of this description, it is always necessary to calculate upon the thickness of the wall—that is to say, if it be required to make the sunk fence 18 inches wide at bottom and 8 feet wide at top when finished, and if the wall is to be 18 inches thick, it will be necessary to make the opening at least 3 feet wide at bottom in the first place, and 9½ wide at top. In building the wall upon a sunk fence, it ought to be founded upon large flat stones, laid upon their natural bed, as at *c*; and these ought to extend at least 3 inches wider than the bottom of the wall. The wall ought to be at least 16 inches broad at bottom, and 13 at top immediately under the cope; the copestones ought to project 2 inches over the wall upon the ditch side; and the wall should be built of the best stones in the neighbourhood, and well-prepared lime. The copestone should always be above the surface of the ground, as shown at *f* in the figure. We have frequently observed sunk fences of this description tumbling down at a very early period after being built: this was occasioned by the damp ground behind the wall not allowing the lime to adhere to the stones—the wall, as it were, being always kept in a moist state. In order to prevent this effectually, a space of about 8 inches wide should be filled up with dry stones immediately upon the back of the wall, about 3 feet high from the bottom, as represented at *e* in the figure. This acts as a drain for the conducting away of the water, and consequently the building is kept dry and good. In order to carry off the water from behind the wall into the ditch *b*, holes about

Fig. 13.

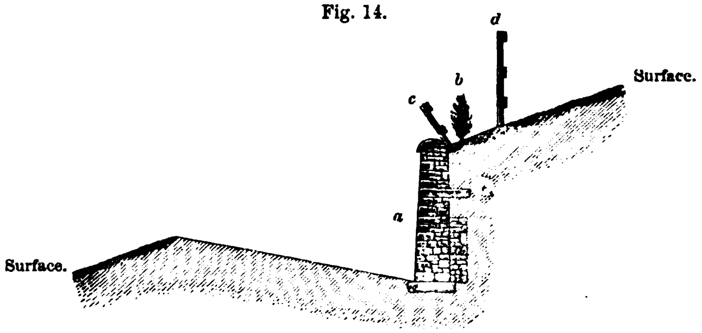


3 inches wide by 6 inches deep may be left at convenient distances all along the bottom of the wall; and these holes should go right through the thickness of the wall at bottom, and should communicate with the drain behind.

In order to make the fence more effectual for the field upon the side of which the wall is built, a low paling or wire fence ought to be erected immediately behind the cope, and made to project over the top of the wall, as seen at *g* in the figure; it need not be more than 2 feet high, and may be either made of wood or iron, as may be found most expedient. Many have a hedge planted upon the top where the paling is shown in the figure, which is indeed a great improvement where shelter is wanted upon a high part; but this is not generally necessary with sunk fences upon level ground—where indeed they are not meant to be seen—but only upon slopes where the situation is an exposed one. Fig. 14 will explain the nature of the sunk fence with a hedge, as it is adapted for a high unlevel part, where immediate shelter is found of the greatest importance.

439. We consider the sunk fence, as represented in fig. 14, to be one excellently adapted for a high-lying part of the country, upon the slopes of rising and unequal ground. The wall *a*, which is 4 feet high with cope, may be very properly built of stones, without the addition of any lime if thought necessary, excepting the cope, which should in all cases be put on with lime; and in such a case the wall need not be more than 14 inches through at bottom and 10 inches at top; and if the wall be built without lime, it will not be necessary to make a drain behind, as formerly advised, seeing that the water can perfectly well escape without it. The hedge *b* should be planted about 16 inches back from the top of the wall. In order to protect the hedge while in its young state from cattle upon either side, it is necessary to have a two-barred paling, *c*, upon the ditch side of the hedge, and a three or four-barred one, *d*, upon the upper

Fig. 14.



side. There is a large extent of these sunk fences in the northern districts of both Scotland and England, which answer the purpose excellently, few fences being better adapted for a hilly country—that is to say, where the line of fence runs at right angles with the slope of the ground. In the first instance, there is shelter produced for stock by the wall itself, which is yearly increased as the hedge grows; and ultimately, when the hedge has arrived at perfection, a clothed appearance is produced, which gives a very pleasing effect.

We may further state relative to the building of sunk-fence walls, that it adds much to their strength to have them secured by what are termed through-band stones, as shown in fig. 13 at *d*, and in fig. 14 at *e*. These through-band stones should be put on about two-thirds of the height of the wall, with at least one to every 6 feet in length, and should consist of large flat stones about 3 inches thick, and of a length sufficient to reach from the front of the wall to at least 1 foot into the solid earth behind, into which they should be firmly bedded, in order to prevent the weight of the bank, if it should give way above, from pressing forward the building. Another point to attend to in the building of sunk fences, and which adds much to the strength of the whole, is, instead of building the front of the wall perpendicularly, to make it lie back about 3 inches at the top; or, as masons term it, "the top should be 3 inches backwards off the plumb:" this is indicated by the dotted line in fig. 13, which shows the true perpendicularity—the wall standing 3 inches back from it at top.

SECTION III.—THE BUILDING OF DRY-STONE WALLS WITH LIME ON COPE ONLY.

440. The most extensively used fence in the high inland districts of Scotland, Ireland, and the north of England, is the dry-stone wall. From the nature of the country in those high districts, stones are plentiful, and of course easily attainable; from which circumstance it is a fence much in use for all purposes. Stone walls have the effect of affording considerable shelter both to young plantations and agricultural cropping as soon as they are erected for that purpose; and are also of great importance in high countries, as giving immediate shelter to cattle in the adjoining fields, which is a great point in favour of their extensive use. This, of course, is not the case with a young hedge fence, which requires from eight to ten years to produce sufficient shelter.

441. The dry-stone wall used to be built entirely without the addition of any lime or mortar to bind it, and consequently it was always apt to be broken down by any strong pressure, or by cattle

coming in contact with it; but within thirty years past a great improvement has been effected in the building of them by having the top or cope stones all put on and bedded in lime, which keeps the wall altogether in a more firm and compact state than that built upon the old principle of having no lime upon any part of the wall.

442. Dry-stone walls are built of various heights, from 5 to 6 feet; but the most approved height for general purposes may be said to be 5½ feet over all. In giving directions as to the proper manner of executing the work of building dry-stone walls, we shall here give what are termed *Specifications* for building walls of the description mentioned; and as they are of the most approved sort for work of this kind, such a copy of specifications may no doubt prove useful to foresters and land-stewards in general, who may have occasion to superintend such work. The following is a copy of the specifications which we use in erecting any walls we have the management of:—

MINUTE of AGREEMENT between A. B. on the one part, and T. P., residing at S——, on the other part—for erecting a March Fence between the farm of Y—— and the farm of O——, upon the estate of A——.

First,—The stone wall to be erected under the present agreement is on that part of the line of march beginning at the present shepherd's house, and from said shepherd's house to the extreme summit of the hill.

Second,—The said wall shall be built according to the following specifications: The wall is to be five feet six inches high. The foundation must be laid with large flat stones, which foundation must not be less than thirty-four inches over. The setting-off of building upon the same foundation must be twenty-eight inches, leaving a scarcement of three inches upon each side. At thirty inches in height, the wall to have a row of through-band stones, six at least to the rood of eighteen feet. The wall to be built forty-eight inches of double, and the cope and coble to stand eighteen inches. At top of doubles, the wall to stand eighteen inches across. The coble-stones to project at least two inches over the doubles. The cope and coble to be properly bedded, built, and pointed with lime, which must be mixed with the regular and proper quantity of sand. The whole to be finished in a sufficient and workmanlike manner, to the satisfaction of A. B., who is appointed inspector of the work.

Third,—The said T. P. binds and obliges himself to execute the whole of the work, in terms of the above specifications, at the price of   per rood of eighteen feet lineal measure, and to complete the same before the first day of   next, but with power to the inspector above named to extend the time for building as he may see proper and right.

Fourth,—The said T. P. further binds himself to uphold the said wall for three years from the time that the work is finished, and at the expiry of that period to deliver it over to the proprietor in a proper state, and to the satisfaction of the said inspector, or any qualified person who may be appointed by the proprietor.

Fifth,—The whole of the stones used in building the wall must be of good quality, and approved of by the inspector above named. And no crop of rock or wasting stones shall be used; and the contractor shall pay the tenants of Y—— or

O—— for any damage they may sustain from quarrying or driving the stones through their fields or over their grass lands.

Sixth,—The contractor, on receiving full payment of the price, shall either find good security for implement of the contract, or leave in the hands of the proprietor the sum of sixpence per rood for the said period of three years. In witness whereof, these presents, written by A. B., are subscribed by the said A. B. at A——, the twenty-third day of May, in the year eighteen hundred and eighty, before these witnesses, P. S., W. M., and R. S.; and by the said T. P., at S——, upon the day last mentioned, before these witnesses, J. P. and A. H.

P. S., *Witness.* A. B.
W. M., *Witness.*
R. S., *Witness.*

J. P., *Witness.* T. P.
A. H., *Witness.*

443. Having given the above form of specification for the erecting of stone walls, we consider it superfluous to add more upon that point, as any intelligent man may, from consulting the same, be perfectly qualified to take charge of such work. The building of this description of wall forms a business separate from that of a forester. No forester or land-steward can be expected to be an adept in building stone walls himself: all that is required on his part is to know how the work ought to be conducted upon right principles, and to be so far a practical judge of the matter as to detect what is wrong from what is right as the work proceeds. There are enough builders of walls in most districts where such fences are in general use who can be got to do the work at a fair rate; and all that is required of the inspector is to see and to be able to know how the work should be done. We may, however, here state, that in building stone walls the inspector should examine minutely, as the work goes on, if the same be well built together—that is, he must see that no open spaces be left in the body of the wall, which should in all cases be firmly packed with the smaller stones; and the method which we take, when suspicious in this matter, is to give the wall a stroke with the foot about half height on the one side, and if opposite to this part where we strike the wall it come out a little, just in proportion to the stroke given, as may be observed by another person on the opposite side, the wall may be considered *well packed;* but if the stroke of the foot does not tell upon the opposite side, and cannot be observed by the eye, it is certain that the wall is hollow within, there being no due solidity throughout so as to cause one stone to press upon another from side to side when the stroke is given. The inspector ought also to see that all the stones used are put or laid on their natural bed, and that every individual stone rests upon two lying under it, and never upon one.

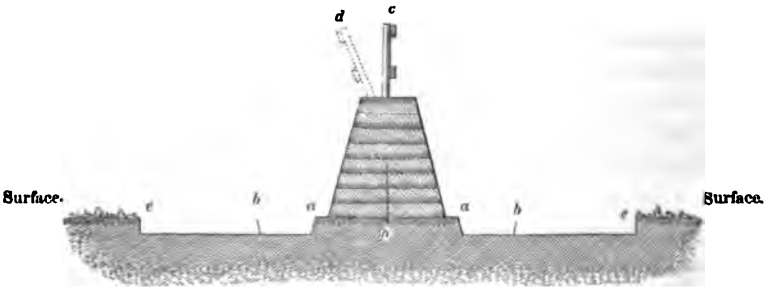
444. The cost of erecting stone walls of this sort differs in different parts of the country, that depending entirely on the price of labour in the neighbourhood where the wall is to be erected, as well as upon the convenience of getting stones for the purpose. If stones are to be carted far from the line of fence, the expense becomes considerable; but the stones being laid down, it is generally got done for 6s. per rood of 6 yards, including the cope and coble well put on with lime. A wall 5 feet 6 inches high, such as specified above, requires about twelve cart-loads of stones to the rood; and when the quarry is opened, and the nature of the stones observed, it will not be a difficult matter to calculate the quarrying, cartage, and building, in any particular district.

SECTION IV.—THE BUILDING OF TURF DYKES WITH WIRE FENCE OR PALING ON TOP.

445. In many high-lying parts of the country, where stones are not easily got at, and where, upon account of the nature of the soil, it would not be advisable to plant hedges, a very neat and answerable fence is often put up for the purpose of enclosing fields on high-lying moorland districts termed the *turf dyke.*

The nature and dimensions of turf dykes, as generally built on these parts of the country, will be at once understood by referring to fig. 15, which is an end section of a turf dyke; and as they are not, like stone dykes, built by a class of men making such work their business, but must be built entirely under the eye of the forester or land-steward, we shall give an outline of the method of erecting them, so that any intelligent man, from consulting the figure and directions herein given, may be enabled to erect them anywhere.

Fig. 15.



446. The line for the erecting of a turf dyke being laid off by a set of pins running along the tract of ground upon which the fence is to be, the operator, in beginning the work of building, first meas-

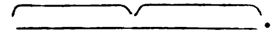
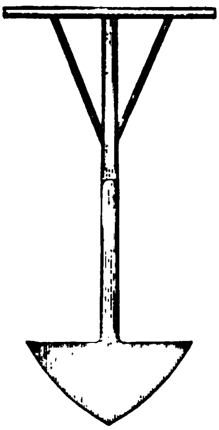
ures 18 inches from the centre of the line of fence as at *o*, to one side as at *a*, where he fixes the end of his line into the ground, and, stretching it along the run of fence as far as his line will reach, he fixes the other end of it 18 inches from the centre, in the same manner as at the end where he first started, and of course upon the same side of the fence; and having his line tightly stretched and *pinned* exactly 18 inches from the centre at any given point, he next proceeds to edge off with a spade the whole length of the line, in order to form one side of the foundation-stance of the dyke. In edging off the side of the stance along the line as has been stated, the operator must cut the surface or turf standing with his face to the field and his feet upon the foundation part of the intended dyke, and this in order that the edge of the stance, as at *a*, may be cut with a considerable slope outwards, as shown in the figure at *a*, upon each side. This sloping of the edge of the stance or foundation is meant to answer a twofold purpose—namely, the turf when cut from the ground with a slope, when laid on in the building of the dyke, corresponds with its sloping upwards; and the edge of the stance, when finished in a sloping manner, lasts much longer than it could do if it were cut perpendicularly. In the same manner the other side of the stance should be cut or edged; measuring also the other side 18 inches from the centre to the opposite side, making the foundation 3 feet wide over all, as seen from *a* to *a*. The foundation having been marked off as has been directed, the operator next proceeds to measure outwards from the edge of it, as from *a* to *b*, upon each side, a turf 15 inches broad at top; and placing his line to the same measurements, he edges off with his spade—which should be an old half-worn one, kept pretty sharp—a line of turf 15 inches broad, the whole length of his first line on each side of the stance; and it must be observed here that, in edging off these turfs upon each side, the operator must cut them with his face to the stance of the dyke, in order to make the outer edges of the turf slope contrary to the inner edges, as shown in the figure at *b b*; consequently the two turfs, when cut and turned upside down and laid along the side of each other upon the foundation, will appear thus . This answers a twofold purpose as the work proceeds—namely, the turfs are at once prepared to answer the sloping of the dyke as it progresses upwards; and as the turfs, in the case of joining them in the centre of the building, are much improved by having a portion of earth put between the seams, this can at once be done by filling up the opening caused by the contrary slopes meeting in the centre, which opening is at once readily filled from paring the bottoms of the turfs when lying as turned up out of the earth, and levelling them for another layer of turf coming above progressively.

Fig. 16.



The two lines of turf being formed by edging them off with an old sharp spade, as directed above, a second man follows with what is termed the *turf-spade* (see fig. 16), with which spade he cuts the turf-line, now formed by the man before him, right across into convenient lengths, say 18 inches; and as he cuts the turf into those lengths, *proceeding backwards*, he by a jerk of the implement turns each turf as it is formed with its grass side uppermost. Each turf, as it is thus turned up, is laid hold of by a third man, who lays it upon its bed in the forming of the dyke, &c., always taking care to lay the first course of turf 3 inches within the outer edge *a*, on each side, which is meant to form the margin, in order to support the dyke the more firmly. When the three workmen have got the first course of turfs laid on the stance, they all proceed to have them properly placed, joined in the seams, levelled, and made properly firm; and in the same manner they proceed throughout, one edging off the turfs with a line to an exact measurement corresponding to the width of the dyke as it advances; consequently each succeeding layer of turf, as it is laid on above another, will be proportionally narrower than the one under: a second cuts the turf across into convenient lengths, and heaves them up for his neighbour in order to lay hold of them the more readily and put them upon their place in the building. From the figure representing the turf dyke, it will be observed that the same is built from materials taken equally from each side; and this is necessary in order to the more speedy building of the whole, as well as taking an equal proportion of the surface from each side, which will not cause the making of the one field poorer than the other, as would be the case were the turf taken all from one side.

The thickness of the turfs must in all cases be determined by the nature of the soil. If the soil which forms the turf be light and sandy, the less of such material that is taken up the better, as it is extremely apt to moulder down quickly—therefore, in a light sandy soil, do not pare the turfs thicker than 3 inches; and if the soil be heavy, 4 or 5 inches may answer; but as a general rule in this matter, do not take the turf thicker than you have plenty of the fibrous roots of the grass in it.

It will be observed from the figure that the first four layers of the turf are double—that is to say, two in breadth; and this is necessary, for the great breadth of those under turfs would render the work difficult were they put on whole. Our rule in this case is to make the under half double turf, and the upper half single; and in all cases we put on the upper turf with the grass up.

447. These dykes are generally made about 36 inches broad at the bottom, and tapering regularly upon each side to 14 inches at top.

448. In the erecting of all turf dykes, it is of the greatest importance to the future welfare of the same as a fence to build them at the offset a few inches higher than it is ultimately intended they shall be; because they in almost all cases subside a few inches shortly after being put up. This is the more necessary to be kept in view where the soil or turf of which the fence is built is of a mossy or soft nature; and of this we have indeed had ample experience, which makes us desirous of guarding others against mistakes of the same kind. And in order to make provision against too much subsiding, we here recommend the following hints: Where the natural surface is very rank of grass or weeds of any sort, cut the same as bare as possible with a scythe previous to cutting the turf; and in the building of the same, if they are damp and spongy, make the dyke at least 9 inches higher than you wish it to be—that is to say, if you wish your turf fence to be 30 inches ultimately, make it 39 or 40; but if the turf used be of a moderately firm, loamy soil, 3 inches may be quite enough to allow for subsiding. Where it is intended to have a paling fence upon the top, as is always necessary unless the dyke be made very high, such a paling should not be put up until the fence has well subsided, else it would fall considerably under the paling afterwards.

449. In all cases of erecting such turf dykes, it is absolutely necessary to erect a low wire-fence or a two-barred paling on the top (see fig. 15 at *c*), in order to prevent sheep or cattle of any description from getting over into a plantation or adjoining field. If the fence is placed upon the edge of a wood, and meant to protect it only, the paling may be put up as represented in fig. 15 at *d*; but if it is put up for the purpose of dividing two fields, then the paling must be put up as represented in the same figure at *c*.

450. Turf fences, from their being in all cases of a temporary nature, should not be erected where stones can be conveniently got for making stone dykes, as the latter kind of fence is in all respects preferable. The only case where they are at all to be recommended is on high-lying moorland parts of the country, where stones cannot be conveniently had at a moderate expense, for the building of stone dykes, and where a wire fence alone is objectionable, on account of its producing no shelter to stock. On the sheep-grazing districts of the west of Scotland, turf fences of the class described in the foregoing are extensively used for subdivision, as they are both cheaply erected and produce a considerable degree of shelter to the stock.

SECTION V.—THE BUILDING OF STONE WALLS WITH WIRE FENCE ON TOP.

451. We may here refer to a very useful fence, which is now frequently used in hilly districts where the particular object in view is to keep back sheep, &c., and which is even more suitable for that purpose than the fence described in the immediately foregoing section. In hilly districts, although a good stone wall is erected, light sheep will frequently get over it, and be the cause of much trouble and annoyance. In a case of this kind it is better to erect a stone wall similar to the one already referred to in Section III. of this chapter; excepting that a projecting copestone is not required, and in its place a low wire-fence is used, which proves very effective in preventing any sheep from getting over.

452. The wall in this case is built quite in the same way as the common dry-stone wall, only that it does not require to be more than 4 feet in height. The stones on the top are firmly put together and bedded in lime, and at every 9 feet there is a good-sized *through-band* stone placed for the purpose of putting in the standards of the wire-fence. The standards are made of iron, and put in at 9 feet apart, and *batted* into the stones with lead, and should stand 2 feet high above the wall when fixed. They are usually made 1¼ inch broad, by ½ inch thick. An iron straining-pillar is put in at every one hundred yards in the length of the fence; these are made 1¼ inch on the side of the square, and should be securely batted into good heavy through-band stones. Such a wire fence requires only three wires, and when completed will stand 6 feet high over all.

Fig. 17.

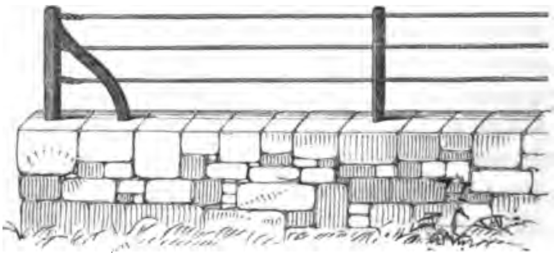


Fig. 17 will give a good idea of this description of fence, and having given it we think it unnecessary to add any further remarks on this fence.

SECTION VI.—THE METHOD OF ERECTING VARIOUS SORTS OF WOODEN PALINGS.

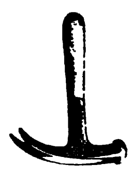
453. The variety of designs for wooden palings is endless; and for us to give in a work of the present nature anything like a description of those termed ornamental palings, would be superfluous; therefore, in the mean time, we shall confine ourselves to the description of a few only, and those such as are considered the most useful for general purposes.

The most generally useful of all wooden palings as a structure for a fence is the horizontal, and this is, when well put up, a fence by no means void of ornament. The wooden paling consists of strong posts, generally about 4 inches diameter, driven into the ground at intervals of 4 feet in the line of fence, upon which posts the bars are nailed horizontally at regular distances from, and parallel to, each other. As there is no fence more commonly in use in highly cultivated parts of the country, it will be of importance to make a few practical observations as to the manner of putting it up.

454. Having fixed upon the exact line upon which a wooden paling is to be erected, ascertain the height that will be necessary for the purpose in view; and having decided upon this—say a four-barred paling—then in this case the fence will require to be about 4 feet high above ground when finished. Next ascertain if the ground be of a hard or soft nature in the line to be erected. If soft, the posts for the paling will require to be put at least 2 feet into the ground, in order to make them properly firm in their place, and to resist the pressure of cattle; if hard, then 18 inches in the ground will be sufficient. And, for our example, in the present instance we shall say the ground is hard; consequently, if the height of the paling, 4 feet, be added to the necessary depth of the post into the ground—namely, 18 inches—we have 5½ feet as the length of the posts; therefore let posts of that length be brought forward and laid all along the line, laying down one post for every 4 feet in length of the fence, which is quite sufficient; and upon having the posts laid down as directed, have the horizontal rails laid down also, beginning at the one end of the line, and laying down 4 bars together continuously to the other, observing, in laying out the posts and rails, to keep them a little to one side of the exact line of fence, in order that the men in working may not be continually interrupted by them lying in their way; and also observing not to lay the rails down carelessly upon the top of the posts, but to have both so distinct that the workmen can have it in their power to lay hold of either posts or rails without their coming into contact with each other. The

general size of posts used for this purpose is about 4 inches diameter, and they may be either round wood, halved, or quartered, as the size of the wood may answer in making them. The best sort of wood for posts which have to be driven into the ground, and which are continually exposed to the extremes of both wetness and dryness in the soil, is the larch. The horizontal rails for paling are generally made 18 feet in length. These are sometimes made of larch, and sometimes of spruce fir or Scots pine. Larch is out of all question the best for this purpose, and is generally sawn to the size of 4 inches by 1 inch. Spruce fir is, in our opinion, the next in quality for paling rails, Scots pine being inferior to it for lasting.

Fig. 18.



455. The posts and rails being all laid out as directed, the operator will next provide himself with a garden-line for stretching along the run of the fence; also a common nail-hammer, or what is termed No. 3 paling-hammer, with claws for pulling out nails (see fig. 18). He will also require a bag for holding the nails, and not have them lying and scattered about, as many carelessly do. This bag may be of leather or of coarse sail-cloth, as may be most conveniently had; and as there are two sizes of nails used in the putting up of paling, the bag ought to be divided into two compartments, by being simply sewed up the middle. Another important tool in the operation of fencing is what is commonly termed the *post-mallet*. Many use merely a block of ash-wood about 10 inches long and 6 inches in diameter for this purpose, having of course a handle to it; but a mallet of this description never answers well, nor can a workman do much execution with it: they ought all to be made of iron, and may be about 12 lb. weight. Fig. 19 represents the iron post-mallet which we use, and which, in the hands of an expert workman, is a powerful implement.

Fig. 19.

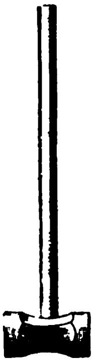
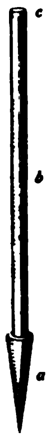


Fig. 20.



If the ground be very hard, and it be considered difficult to get the posts driven in—not only on account of the loss of time that would be occasioned by having the men toiling and beating upon a post for some minutes before they could get it the desired depth into the ground, but also of the waste of the posts—it will be proper and necessary to be provided with what is termed a *borer* (see fig. 20). This implement consists of a heavy piece of iron, *a*, which is pointed, round, and hollow in the centre in order to receive the handle *b*. This pointed piece of iron—or *shod*, as it is termed by the workmen—may be made about 12 inches long, and about 3 inches diameter at the top where the handle is inserted. The handle should be about 4 feet long, in order that the operator may have the more lever power upon it; and in making a hole for a post with it, it is forced into the ground by repeated strokes downwards from the workman, who holds it by the top, *c*, in his hands,—and is found very powerful in making holes in hard ground.

These implements, as described, together with the nails, are all that are necessary for the putting up of a paling fence; and having described them, we shall now proceed to show how they are used in the work.

456. In commencing to put up the paling, all the materials being laid down, first stretch the line along the run of the intended fence, and pin it down about 2 inches to the one side, in order that the posts may be put in the exact run intended for them; and having done this, cut a piece of wood the exact length that you wish the height of your posts to be above ground when driven in; then, if the ground be hard, take the borer and make a hole with it for the first post; which being done, send the post down by the mallet to the desired depth, measuring the proper height of it above with the stick for the purpose; or, which may be more handy, the height may be marked upon the handle of your mallet and applied at once to the post. If your rails are of unequal lengths, next proceed to lay a single bar along upon the ground by the side of your line, allowing an overlap of about 5 inches at each joining; and having done this, proceed first to put in a post at the joinings of the rails, without regard to exact distances in this case. Upon having a post driven into the ground at each joining of the rails, next proceed to put in the posts between these, to as nearly 4 feet as the spaces will permit; and after you have the posts driven in regularly as far as your line is stretched, look over them and see that they are regular both on the top level and in a line upon the side view: this can be readily done by beating down one where too high, or beating with the mallet to a side any that may be a little out of the line. Having the posts all regularly in, and in proper state, let two men take hold of a rail and place it along the top, forming the upper bar, and observe to have the end of the rail commencing upon the first post nearly on a line with the perpendicular of it—that is to say, merely covering the breadth of the post—and the man upon the other end of the rail will observe to have it about 2 inches over the breadth of the post upon which he nails it: this is in order to form a *splice* or joining to secure strength in the part; and in this state let the first bar at top be nailed on, observing to keep it rather under the top of the posts. Upon lifting the second bar, which should be a continuation of the upper one, let the man who is hindmost keep his end of the bar about

2 inches behind the post upon which his neighbour nailed his last joint. In this manner the two men will go on with the putting on of the top bar the whole length of the line of posts put in, and in the same manner return with the second bar, which should be about 9 or 10 inches under the upper or first one. In putting on the second, third, and fourth bars, it is not so necessary to have the joints of these made upon the posts as directed for the upper bar: they may be joined in the middle, or where it may chance to happen, according to different lengths of the rails; because the three under bars are not likely to require to have so much strength as the upper one, which is always pressed upon by cattle, &c. The second bar being nailed on, the third one should be put on about 7 inches under it, and the fourth or under one, about 6 inches under the third. The reason of thus making the bars closer as they come down upon the posts, is the more readily to keep back sheep or lambs, those spaces being most on a level with their bodies.

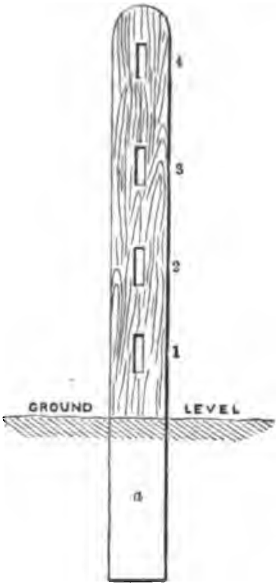
In the same manner the whole of the length of the fence is put up, one line-length after another; and in this manner two active expert men will put up twenty-five or thirty roods in one day, where the soil is moderately soft.

457. In erecting wooden palings, it will not always be found that four bars will answer every purpose; for where cattle, sheep, and lambs are grazing, five bars will often be found necessary to keep them in; as also it may often happen, that where there is a height upon the line of the ground upon which the fence is to be run, three bars may in such a situation prove as effectual a fence as four or five in other situations.

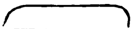
458. There is another description of horizontal paling excellently adapted to protect plantations and to subdivide fields, of which a large extent is now erected in various parts of the country. It is of a very much stronger character than the one described in the five preceding paragraphs, and forms a more permanent and reliable fence where heavy cattle and horses have to be guarded against. This paling consists of posts put into the line of fence at 9 feet apart, with four or five horizontal bars fixed between each pair, and the usual height over all is 4 feet, measuring from the land level. The posts are made from good and matured larch or pine timber, 6 feet long, and sawn to a scantling of 7 by 3 inches. The rails are also made from matured timber, 10 feet long, 5 inches broad, and 1½ inch thick. The posts, made of the dimensions stated, are mortised to receive the rails, as no nails are used in the erection of this sort of paling. The mortises are made right through the thickness of the posts, and of dimensions suited to the breadth and thickness of the rails which they are to receive—viz., 5 inches by 1½ inch. In order to make the fence proof

against small sheep or lambs, the mortises are arranged in the posts so as to have the lower bars closer to one another than the upper ones. The following figure will explain this:—

Fig. 21.



The portion *a* which is inserted into the ground is 24 inches in length; the portion betwixt the ground-level and the opening or mortise No. 1 is 6 inches; the portion betwixt the mortises 1 and 2 is 6 inches; that betwixt the mortises 2 and 3 is 7 inches; that betwixt the mortises 3 and 4 is 9 inches; and above the uppermost mortise there is 5 inches of whole timber left in order to maintain sufficient strength to prevent splitting after all the mortises are made, and in driving home the bars.

In order that the rails may be made to overlap properly and firmly, as well as that they may be inserted into the mortises, a slice is removed from each end of every one of them, and for this purpose a sharp *adze* is used. In removing the slices from the ends of the rails, it is done all from one side ; so that when any two ends are put into a mortice, it is only necessary to place the sliced side of each, the one to the other, in order to have a complete junction, and a continuous line of rail. The slice may be from 4 to 6 inches long.

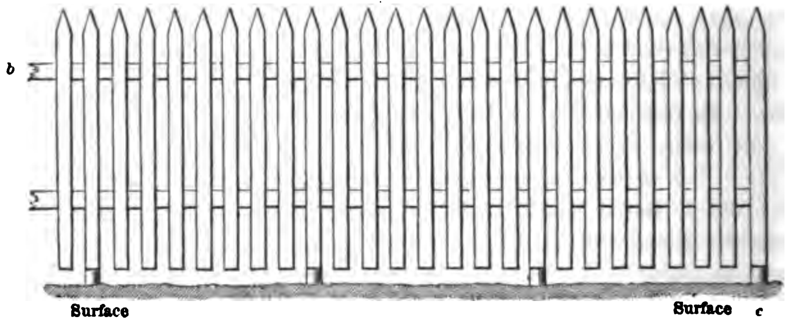
459. We shall give a short description of the usual mode of erecting this sort of fence. The timber is prepared for it as specified in the foregoing paragraph, and should be laid down along the line of fence in a regular and systematic way before commencing to erect the fence, and while this is being done, the holes or pits should be made at exactly 9 feet apart, to receive the posts. In erecting the fence, after the first post has been fixed in its place,—and each must be made firm in its place by using four stones—the first two, one on each side of the post in the bottom, and the other two, one on each side of the post at the surface of the hole, all put in firmly betwixt the posts and the outer edge of the hole,—the ends of the four bars are at once put into their mortises in it. This being done by two men, other two are at the same time employed putting the second post into its hole, and before they commence to fix it they place the other ends of the four rails, which were inserted into the first post, into the corresponding mortises in the one at which they stand; and immediately after this is accomplished, they fix the second post, while the two men who were engaged with the first go on to the third one, and so on alter-

nately, always inserting the rails into the last post before fixing it in its place on the line; in the same way any length of the fence may be put up. In various parts of the Highlands of Scotland, there are fences of this kind which have lasted upwards of thirty years, and this because they had been made of good timber.

460. Next to the horizontal palings which have been described above, the most important and generally useful is the *upright*, which is made of various heights in order to suit different purposes. It will be enough for us to give an example of the manner of putting up one of these; and by referring to fig. 22 this will be readily understood.

Fig. 22 is a sketch of an upright fence made of larch-wood. The upright spars, as shown from *a* to *a*, may be either sawn wood, 3 inches by ¾ of an inch, or small larch-trees 3 inches diameter, cut up the centre by a saw-mill, according to taste. We shall here suppose that we have to erect a fence of the description above stated, and that it is to be 5 feet high.

Fig. 22.



In the first place, have all materials brought forward, and the line stretched along the run of the intended fence, in the same manner as directed for the putting up of the horizontal fence, and put the posts into the ground in the same manner as there advised, observing to keep them about 4 feet distant from each other, and allow the tops of them to be 12 inches under the extreme height of the uprights; consequently the posts for a 5-feet spar fence will require to be 4 feet high above ground when put in. The posts being put in along the whole length of the first line, and carefully levelled along the tops, at least in such a manner as to correspond with the nature of the ground, the next part of the work is to have the upper rail nailed on to the exact height of the tops of the posts, observing to join the rails upon the posts in the same manner as formerly advised; and the upper rail being nailed on, the second (there being only two horizontal bars in the fence at present under notice) must be nailed on and joined upon the posts in the same manner, keeping about 16 inches from the surface of the ground, or 2 feet under the upper one. In putting on the upright spars upon the framework now formed by the posts and two horizontal rails, have one of them nailed on at the extreme end where you intend commencing, observing to keep the top of this upright 12 inches above the upper rail *b*, and place it at the same time so as to cover the post forming the extreme end, as at *c*—the post appearing at bottom only; and in the same way go on putting on an upright upon the face of every third post the whole length of your line of posts, being very exact in measuring the top of each to 12 inches above the upper bar; and when this has been done, put a nail into the top of each of these uprights, but only so far into the wood as not to be taken out easily without the aid of the hammer. On having put a nail into the top of each, have your line tied to the one upon the extreme end, and go along with it in your hand, making one turn of it round each nail as you pass along, keeping the line tight as you proceed; and having stretched it along the tops of the spars tightly by the use of the nails, the line will now act as a top guide for putting on all the rest of the spars between to their proper height, which could not have been done easily otherwise. The fence being 5 feet high, the uprights will require to be only 4 feet 9 inches in length, they being kept 3 inches up off the ground or surface, as seen in the figure. In putting on the spars, pay no attention particularly to their regularity at bottom, but be very particular as to how they range and take the eye at the top. In nailing on these spars, be careful to have them put on as near the perpendicular as possible, keeping from 2 to 3 inches of open space between each two; and always endeavour to have an upright put on so as to cover each post from the view, which can be easily done by a little attention in regulating them. A fence of this description should always have the spars nailed upon that side which is to be most seen; consequently, this point should always be taken into consideration before commencing the work.

SECTION VII.—THE ERECTING OF WIRE FENCES UPON WOODEN AND IRON POSTS.

461. In the matter of fencing, as well as in that of shipbuilding, this may be truly said to be the "iron age," for wire-fences are now, generally speaking, setting aside and taking the place of most others. This is in consequence of the material of which these fences are made being cheaper than stone erections, and more durable and

ornamental than mere wooden fences. As wire fences, then, are of the first importance in this branch of our subject, we shall enter rather minutely into a description of the practical part of erecting the different sorts of them; and in this we hope to be able to give such directions as may enable any intelligent man to erect them in a perfect manner.

462. There are three different classes of wire-fences in general use—namely, those consisting of wire strained on wooden posts; those erected on iron straining-posts with wooden intermediate ones; and those erected entirely with iron and without wood. We shall describe the mode of erecting each of these classes in the order in which we have referred to them; but before attending to this, we shall refer to a few preliminary points which are necessary to be noticed at the outset.

463. Wire-fences consist chiefly of four parts—namely, the straining-pillars, the standards or intermediates, the stays, and the wires.

464. The straining-pillars are for keeping the horizontal wires at full stretch, and may be of wood, or of cast or wrought iron, batted into large stones, wooden blocks, or cast-iron blocks, sunk and firmly fixed in the ground, and supported by stays. If the line of fence is straight, the straining pillars are placed from 80 to 100 yards apart, and in some instances over 200 yards; but if the line is curved, intermediate ones with stays are required.

465. The standards may be of wood or wrought-iron, and are placed from 3 to 9 feet apart, according to circumstances. They are absolutely necessary to keep the horizontal wires at regular distances apart, and to support the fence as a whole. Wooden standards are either driven into the ground or sunk into holes in the same way as the posts are in a paling fence; but iron ones require to be either batted into stones or driven into sunk blocks of wood, or they may be "self-fixing," or fitted with feet at bottom to admit of their being driven into the ground. Stays are necessary in most fences for the standards at all curves, but these are made much slighter than for straining-pillars.

466. Stays may be of wood or wrought-iron, and are required to prevent the straining pillars from being drawn off the perpendicular by the tension put upon the wires. Iron stays are made double for straining-pillars, and single for standards, and are batted into stones or driven into wooden blocks, or they may have flat blocks attached.

467. The wires are placed parallel, and at suitable distances from each other. They are passed through holes bored in the iron standards, or are fixed with staples to the wooden ones, and are kept at a proper tension by the straining-pillars. To a person not familiar

with the usages of trade, there is often a difficulty experienced in choosing the proper kind of wire. There are only two processes of making wire—namely, *rolling* and *drawing*. The former is the cheaper process of manufacture; because an inferior quality of metal can be used in it as compared with the latter, which is a more tedious and testing process. In purchasing wire, the best kind can always be known from its being in long lengths, while the inferior quality is in comparatively short lengths. Of course wire in short lengths can always be bought at a cheaper rate than in long lengths, but when wire of good quality is wanted, a fair price should be given for it in order to have it of long lengths. In erecting wire fences, it is of great importance to have them made of the best of wire. Although it may cost more at the time, yet it will certainly be found much cheaper in the end, as the workmen's time lost over an inferior quality of wire is frequently of more value than the wire itself.

468. Wire for fences is sold under the following names:—

1st, *Bright wire.*—This quality is what is called *cold drawn*, and is very hard. If the fence is to be rendered elastic, and capable of resisting pressure without yielding, this kind is to be preferred. It is difficult to knot, and is recommended where experienced workmen are employed in the erection of the fence.

2d, *Annealed wire.*—This quality is also cold drawn, but is afterwards annealed, which softens it, and therefore renders it more pliable to knot, and easier to erect by inexperienced workmen.

3d, *Black wire.*—This quality is rolled, and is not sold in such long lengths as the preceding. It is soft, is not elastic, but knots easily, and is well adapted for ordinary purposes where cheapness is a consideration.

4th, *Galvanised wire.*—This is the annealed drawn wire galvanised. The advantage of this kind is its freedom from rust, independent of paint or oil; but the process of galvanising renders it more brittle.

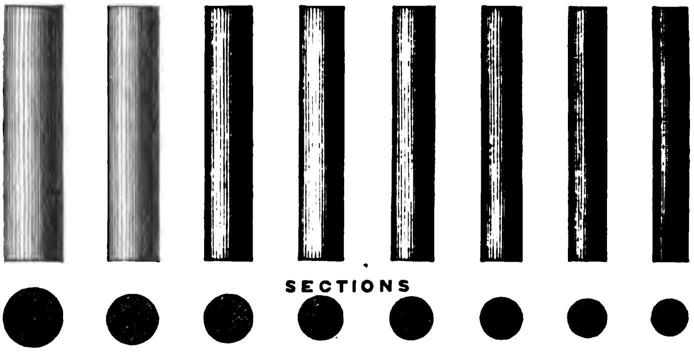
5th, *Bessemer steel wire.*—This description of wire can be had bright and annealed. It bears a higher strain than iron wire, can be depended upon, and will tie cold without breaking.

469. There are various sizes of solid wire used in fencing, each size being known by a certain number, so that when any particular size is wanted, it is merely referred to by its distinguishing number. Fig. 23 shows the exact size of each kind of wire sold, together with their numbers, and to each is added the distance 1 cwt. will usually run.

470. Besides the solid kinds of wire just referred to, there is also the *Galvanised strand or rope-wire.* It is composed of seven or of three small galvanised wires or strands, twisted together like a hempen rope. It bears a much greater strain than solid wire, and con-

tains a greater number of yards to the cwt. than the corresponding numbers of solid wire. Of course the seven-ply wire or strand is the

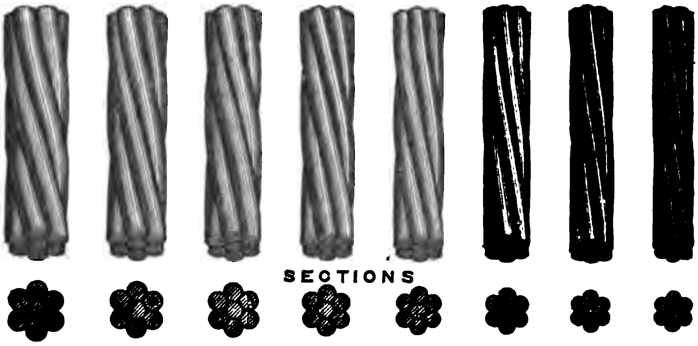
Fig. 23.



	1	2	3	4	5	6	7	8
Number of Yards per cwt.	165	190	280	276	332	395	479	573
Number of Yards Bessemer Steel Wire per cwt.	—	—	—	—	—	376	442	560

strongest, and is now much in use in this country for general fencing purposes. It is soft and pliable, and is generally made in much longer lengths than the solid wires. Fig. 24 shows the various sizes of the seven-ply wire, together with the number of yards to the cwt. of each.

Fig. 24.



	1	2	3	4	5	6	7	8
Number of Yards per cwt.	220	260	280	320	430	500	600	700

471. Having made the foregoing explanatory remarks as to the character and uses of the chief materials used in erecting wire-fences,

we now come to describe particularly, as was proposed, the practical part of erecting the different classes of them.

Wire fences strained on wooden posts.

472. Figs. 25 and 26 represent the extreme ends of a wire fence upon wooden posts, 3 feet 9 inches high, and adapted to resist sheep and cattle.

The exact line for a wire fence being fixed on, have the first *post* or *straining-pillar, a,* fig. 25, made as there represented. Have it made of the best larch timber, taken from a full-grown tree, the wood of which may be considered matured and full of resinous sap; and not of the wood of a young tree, as is too often done, which, although apparently as good, will not endure nearly so long as that of a full-grown tree. The wire fence, as here represented, is in general made 3 feet 9 inches high from the surface of the ground to the top wire *d*; consequently the post *a*, which should be sunk 3 feet 6 inches into the ground, will require to be made 7 feet 6 inches long, allowing 3 inches for the round upon the top above the level of the upper wire, as at *c*; and if it is to be made octagonal in shape, as is generally the case, it will require to be at least 8 inches diameter. In preparing the straining-post, it is advantageous to the strength as well as the duration of it not to take any of the outer wood off the part which is to be sunk in the ground; for the more bulky that part is, so much the greater, in every respect, will be the stability of the work. Therefore, in dressing the straining-post, only do so to

Fig. 25.

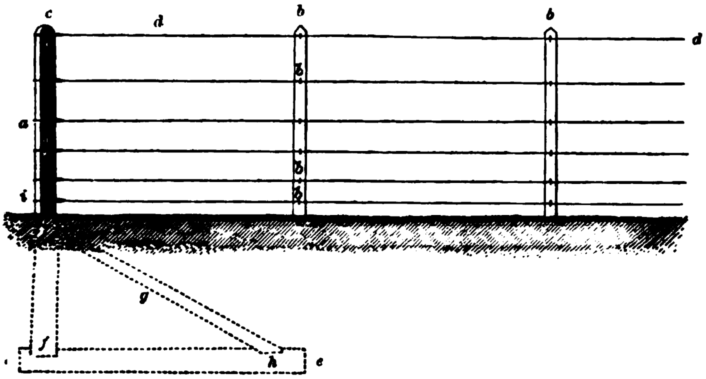
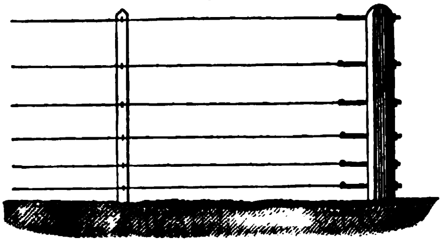


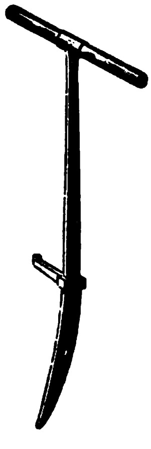
Fig. 26.



the part which is to be above ground. Having the post made with ½-inch holes bored through it at proper distances for the reception of the wires, as shown in the figure, have another piece of larch prepared, 6 feet long, 8 inches by 6 inches, to act as a sole for the post to rest upon in the ground, as indicated in fig. 25 by the dotted lines at *e, e.* In this sole cut out a part upon the broadest side, about 2½ inches deep, the whole breadth of the wood, large enough to hold the bottom of the post in it, as at *f,*—observing to leave about 6 inches upon the end for a heel; into this groove fix the bottom of the post, as shown in the figure, and secure its firmness by two very large nails driven through the post into the sole. This being done, have another piece of larch-wood, *g,* of such length as to have the one end fixed in another groove to be made near the point of the sole, as at *h,* and the other end in another groove, to be made only 1 inch deep, upon the post, as at *i.* This piece of wood, which should be about 7 inches by 4 inches, is called the underground stay, and is meant to act as a support against the strain of the wire; while, at the same time, it is not seen above ground, and consequently the fence has a light and neat appearance when finished.

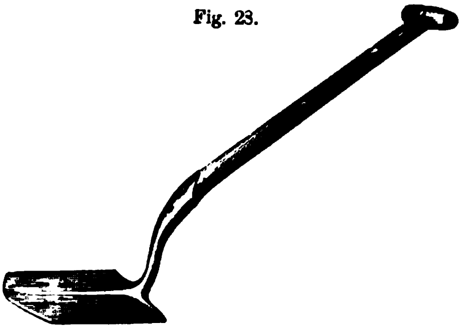
473. The first straining-post having been completed in the manner stated, the next step in the work is to have a pit dug in the ground for its reception, observing to make the one end of it exactly where the fence is meant to begin, extending it in the direction of the line of fence, so far as to hold the sole when put in, and about 3 feet deep. In making these pits for the reception of the posts, the ground is in almost all cases found so hard as to require picking, in the under half at least; and as it is necessary to make the pits as near the exact dimensions of the wood to be put in as possible, in order to have the more solid ground about the posts, it is often a work of considerable difficulty to make them without proper implements. The implements most suitable in the making of pits for wire-fence posts, as also for gate-posts in general, are the common garden-spade, for digging off the surface turf and upper soil, and the *foot-pick,* fig. 27, which is preferable to the common hand-pick. There being no sufficient room for a man using the hand-pick, but with great disadvantage in the making of pits, in all cases of this nature the foot-pick should be used, which is a most efficient instrument, enabling a man with great ease to loosen the hardest subsoil or stones in the making of a pit. The *horizontal spade,* fig. 28, is a very useful implement when removing soil. 18 inches under the surface. It has a handle about 2 feet long. With it a man can

Fig. 27.



work with great freedom in the pit, where he is much confined for the want of room; and with it he can in such cases do more than double the work he could do with the common spade.

Fig. 23.

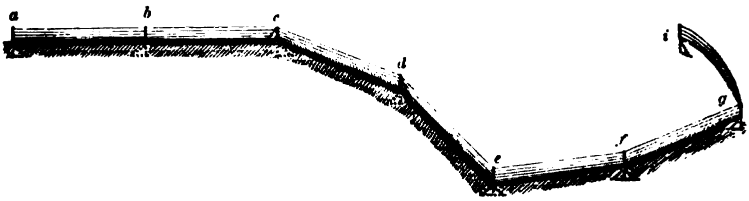


The pit having been made, and properly levelled in the bottom, the straining-post is put into its place, observing to keep it perfectly upright. This can readily be done by the aid of the *plumb-line*. When the post is placed upright, two wedge-shaped pieces of larch-wood, something in the form of the pointed end of a strong post—say about 18 inches long—should be beat obliquely, one into each end of the pit, as at *e*, *e*, in fig. 25, between the solid earth and each end of the sole. This is meant to secure the stability of the sole in its place, and consequently they ought to be well driven home. The earth which comes out of the pit should now be well broken down, and gradually filled into it again. In this filling, not more than 3 inches deep of the loose soil should be put into the pit at once, without having it properly beat to a perfect solidity with what is termed a *rammer*, which is merely a piece of wood in the shape of a common post, about 4½ feet long, having a piece of iron upon the under end in order to make it more heavy for beating the earth. This laying in of loose earth, and beating with the rammer, should take place alternately, until the hole is filled, and the post perfectly upright.

474. Having got the first straining-post put in, observe next if the ground upon the line of the proposed fence is level or unlevel; for a great deal depends upon this, and the manner of going to work must be regulated accordingly. In order to illustrate this clearly, we shall now be assisted by referring to fig. 29, which is meant to represent a continuation of a line of wire-fence both upon level and unlevel ground.

475. We shall now suppose that the first straining-post *a*, in fig. 25, is represented by the post *a* in fig. 29, and is now properly secured in the ground, agreeably to the directions given. Now, the ground from the post *a* to the post *c*, which is perfectly level, we shall suppose to be about 160 yards in length; therefore this space is too great in order to be properly tightened up between the two posts *a* and *c*; we must, therefore, have another post between them, as at *b*. We ought to observe here that in all cases of putting up wire fences on wooden straining-posts, never have them much more

Fig. 29.

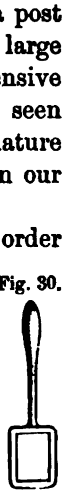


than 80 yards from each other, and in no case more than 100 yards apart. If they are much wider, the proper tension of the wire cannot be attained so as to make a secure fence; consequently, the next step in the progress of the work before us is to put up another post at *b*, half distance between *a* and *c*. This post is put in exactly in the same manner as has already been described for the first one; only it must be observed to put the underground stay of the second post in such a position as to resist the strain of the wire from the post *a*. This is effected by placing the stay the contrary way of the first one, as seen and represented in fig. 29 at *b*, the stay upon the post there not lying in the same direction as at the post *a*, but the contrary; thus making each pair of posts complete in themselves, and independent of another, which is the point required. The second post being secured, the next thing to do is to have the intermediate uprights or standards brought forward, which are represented in fig. 25, *b b*. These should be of the best larch-wood, 6 feet long, and 4½ inches by 3. Before putting them into the run of the fence, have one line stretched tightly between the bottoms of the two straining-posts upon the surface of the ground, and another between the tops, or in the exact position of the intended top wire, running each end of it through the upper hole in each post; and upon having both lines stretched as a guide for top and bottom, in putting in the intermediate uprights, have them put in 5 feet apart, upon the opposite side of the line that it is intended the wire should be put on; or in other words, let it be understood that the hempen line is in the exact place where it is intended the upper wire shall be. Another point necessary to be considered at this stage of the work, is to put the wires upon that side of the posts where it is known there will be most necessity for strength on the part of the fence; for if heavy cattle be upon the opposite side of the wires, they are very apt to press out the staples which hold the wires to the wood, while upon the other side they can have no effect whatever upon it.

With regard to the method of putting the intermediate uprights or posts into the ground, some make holes for them with the spade, while others drive them into the ground by the paling-mallet. We have heard each method advocated as the proper one, but in our opinion it entirely depends upon the nature of the soil along the line of the fence. In many cases it is almost impossible to get a post driven into the ground, owing to the quantities of small and large boulder-stones that are in it. We have seen some very extensive wire fences erected in different parts of the country, and have seen the posts put in in both ways, and with equal success. The nature of the soil and the circumstances of the case must, therefore, in our opinion, be the guide in this matter.

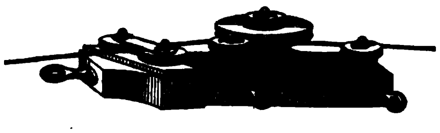
When the posts are beat into the ground with the mallet, in order not to spoil their heads, there is an implement made of iron, the exact shape of the top of the posts, 4½ inches by three inches, inside measure, which fits exactly, and indeed rather tightly upon them. (See fig. 30.) In beating in the posts, a man lays hold upon the top of each by this implement, as shown in the figure; by using it the posts are not hurt on the top by the action of the mallet; and besides, the man holding them thus at the top has a great power over them, and can turn them at will if they happen not to go in right; it is called the *post-guide*.

Fig. 30.



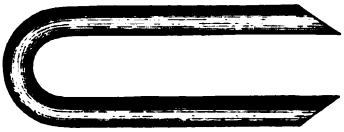
476. The posts having been put in 5 feet apart, the whole length of the line between the two first straining-posts, very exactly with the run of the line both at bottom and top, and 3 inches of the top of each upright being left above the line or run of the upper wire, in order to strengthen the fixture of the wire at top,—as may be observed by glancing at fig. 25, where it will be seen that the top of each post is a little above the top wire—the next thing will be to have the wire prepared or drawn for putting on between the two straining-posts. The wire, as it comes from the manufacturers, is in general rolled up into bundles, each containing from 40 to 80 or 100 yards in length, and often much longer. If the common wire is used, it keeps its circular form in these bundles, and consequently a wire-straightening machine is required. It is represented in fig. 31, and in using it the wire is pulled through between the two sets of wheels, and is afterwards found straight and ready for use. Some of the better kinds of wire, however, uncoil perfectly straight, and in that case the wire-straightener is not required. Having straightened six lengths of the wire to be used, and laid them down between the two straining-pillars, the next thing will be to have them fixed. Before taking down the line which was stretched between the tops of the

Fig. 31.



two straining-pillars for the purpose of regulating the tops of the uprights, and which, of course, will be in the exact place where the top wire of the fence is intended to be, have it stretched very tightly; when properly tightened, mark with a carpenter's pencil the exact track of the line along the top of the posts, and then take the line down. On its being removed, have staples prepared for nailing the wire to the posts. These staples are made of the same material as the wire itself, are of different sizes, but those made 1¾ inch long are the best for general use. (See fig. 32.)

Fig. 32.



477. Have one of these staples driven into each post upon the mark made by the pencil, and right in the middle of the wood; and upon having them driven in about half length all along, have the upper wire run through the upper hole of the first pillar, and through each of the staples in the posts. One end of the wire is fastened to the post *a*, fig. 25, by being brought half round it, and twisted by means of the *turn-key* (see fig. 33) round the wire inside of the pillar or post. Should it be too short to reach the next straining-post, it must be joined to another piece of wire of the same description, and brought up to it. In joining one piece of wire to another, it is done by forming an eye or loop on the end of one of the wires; in forming this eye, the end of the wire is held by means of the *clams* (see fig. 34); and while one man holds the wire by means of this instrument, another assistant turns or twists the end round the wire, in the same way as at the post, by means of the turn-key, which has holes in it for receiving the end of the wire; or by a pair of round-mouthed *pliers*, which are often used instead for this purpose. An eye being made upon the end of one of the wires, the end of the other wire which is to be joined to it is then passed through it, and twisted in the same manner as the other, thus completing the joint or knot, which, when finished, will have the appearance shown in fig. 35. This joining of the wires should be done in a neat and workmanlike manner, as when well done it always adds very much to the appearance of the fence.

Fig. 33.

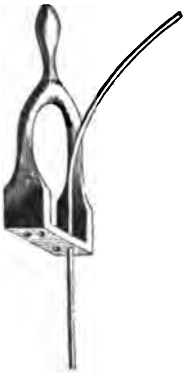


Fig. 34.

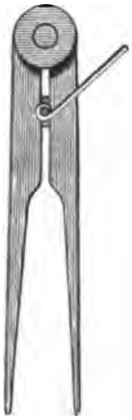
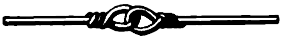
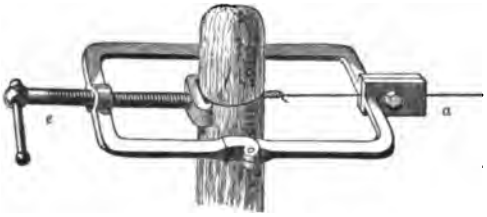


Fig. 35.



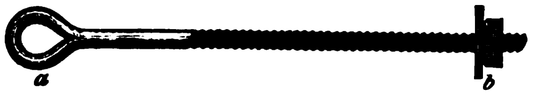
478. The joining being finished, and the wire brought up to the second straining-post, it is then cut a foot beyond the post, where it is now to be finished. In fixing the wire upon this second straining-post, pass it through the upper hole prepared for it, corresponding to that on the first post, then have the wire properly strained, and securely tied round the post. In order to have the wire brought up to a proper tension a *straining-machine* is required. There are several kinds of these for the purpose, but the one most generally in use is the common *straining-screw.* (See fig. 36.) This straining-screw is attached to the wire by means of a jointed *vice*, as at *a*, which is opened or closed at pleasure by means of a *screw* and *nut*, wrought by a screw-key, and can be made to hold as tightly as if it were all a solid piece; the wire being passed through the upper hole of the post, as already directed, it is taken hold of by opening the vice at *a* and screwing it tight upon the end of the wire; but previous to doing this, the instrument requires to be adjusted by placing the saddle attached to the inner end of the screw right upon the post. This done, and the straining-screw all in readiness, screw up the wire, by turning round the handle *e*, till the desired tension is gained, which may be known from the wire in its whole length between the straining-posts being tight as a string upon a musical instrument. The wire which projects or hangs out behind the post is now taken half round the same, and is then fastened in the same manner as at the other end, when the straining-screw can be removed.

Fig. 36.



479. In putting up wire fences, instead of tying the wire round the second post, as we have described, which is the usual way, there are *screwed straining eye-bolts* also used for the purpose of straining the wires. (See fig. 37.) The wire is attached to this through an eye upon the one end, as seen in the figure at *a*, and passing the bolt through the hole in the post, a *nut* and washer (*b*) are put upon it on the outside of the post. The wire is easily tightened by simply screwing up the nut, and the washer is for preventing it cutting into the post. By this means the wire can be tightened or slackened at any time when it becomes slack or tight,—and it does become slack in summer from

Fig. 37.

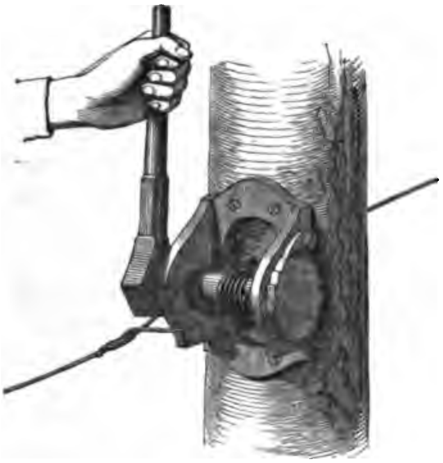


expansion by heat, and too tight in winter from contraction by cold—whereas, when it is tied at both ends, it cannot at any time be made tighter without undoing the tie, and tightening it up anew by the aid of the straining-screw. These screwed eye-bolts are made of different lengths, but in this case they should not be less than 12 inches. For wooden posts they are generally made 15 inches in length; and as shown in the figure can be had from Messrs Bayliss, Jones, & Bayliss, Victoria Works, Wolverhampton, who supply them either black or galvanised, and at different prices, according to size.

They are also represented in fig. 26, which is meant to show the one end of a wire fence tightened up by them; and in this case figs. 25 and 26 exhibit the two ends of one wire fence, the wires upon the post in fig. 25 being tied, and those upon fig. 26 being secured by the screws.

480. Fig. 38 represents another form of strainer for wire fences on wooden straining-posts. It is more effective than the screwed eye-bolts, and is very simple in construction. The figure will at once show for itself how it is wrought, which is simply by attaching the winder to the post with screw-nails, so that the wire coming through the hole in the post can be wound round the crank, and strained up by turning the key as shown in the figure. These *registered winders*, as they are called, can be obtained from Messrs Hill & Smith, Brierley Hill Iron Works, Dudley, or from any of the principal fencing manufacturers in the country. They also possess the advantage of enabling a man to tighten the wires at any time when they require it. Of course one of these winders is required for each wire, and remains on the fence for use at any time.

Fig. 38.



481. In the same manner as has been detailed for the putting on of the upper wire of a wire fence, all the others also are put on—in all cases observing to keep the distance between the wires closer at bottom than at top. In general, where sheep or lambs are, the distance between the two lower wires should be 5 inches, widening them gradually to 10 inches between the two upper ones.

482. Fences of this description can be made of any convenient

height to suit the purpose for which they are required. For deer they are generally made 6 feet high,—these having ten wires in depth, instead of six as is generally allowed for sheep and cattle. Fences for deer, however, are now usually made of iron, which is found more suitable. However high these fences may be erected, the work is all done upon the same principle, save with this difference: in erecting a wire fence above 4 feet, it is always necessary to have an iron stay put to the straining-posts above ground, as well as a wooden one under, in order to secure them more perfectly against the strain of the wire. These stays are sunk into stones, and batted with lead or cement: the stone for one of such stays ought not to be less than 18 inches cube, and sunk about 3 inches under the surface.

The higher the fence the deeper also ought the post to be sunk in the ground. In erecting a fence of this description 6 feet high, the sole of the ground stay would require to be 4 feet under the surface. The staples should never be driven home in the uprights; but there should be room left for the wire to move through them, else the strainer will not have the effect of tightening the wires when it is found necessary. As soon as a wire fence is finished, the posts, if made of properly seasoned wood, ought to be painted with black varnish, or receive a coat of coal-tar, and the wires with common oil-paint; for if it is allowed to remain any time without being painted, the wire will soon become rusted, and will be apt to break if weakened by being corroded. For our recommendations as to the preparing of timber for fencing, with a view to its better preservation, see Section 4 under Chapter XXV.

483. What we have said relative to the putting up of wire fences of this kind is only applicable to a length between two straining-posts, and that upon level ground; and in order to make this branch of fencing more properly understood, we shall continue our observations a little further. When we last referred to fig. 29, we said that from the post *a* to the post *c* was all level ground, being 160 yards in length. We have now finished the half of this space—namely, from *a* to *b*—in the above details of the manner of erecting the wire fence. We shall now suppose that we are to erect the other stretch, from *b* to *d*. In this part it must be observed that the posts *c* and *d* are erected upon points from which the ground falls away suddenly; and in this case it is necessary to have either double wooden stays under ground, as shown at *e* and *f*, or an iron stay to each above ground, upon the sides of the posts opposite to those upon which the underground wooden ones are. The reason for having these extra stays at these two posts is, that supposing the wire to be suddenly broken between *c* and *d*, the great strain acting upon these two posts, from *a* on the one hand, and from *e* on the other, would very likely

pull them suddenly backwards, and disarrange a considerable part of the fence. Now, the simple precaution of having another stay put up at each, prevents this from taking place under any ordinary circumstances; but in every other respect the wire fence is put up in the same manner as has already been detailed. In all hollow parts of the ground upon which a wire fence is erected, the posts at such parts should be sunk deeper than upon level or prominent parts; and the soles used there should also be much heavier than those commonly used, and with heavy ground stays, one on each side of the post, as shown at *e* and *f*. The reason for this is, that were these posts put in in a manner which might answer perfectly well at *c* or *d*, the great strain of the wire upon each side of them would not only endanger their security as a permanent fence, but it would draw them entirely out of the ground—a result we have witnessed several times. On a little reflection, it will appear evident that the strain of the wire at *c* and *d* tends to press the posts downwards into the earth—while, on the contrary, at *e* and *f* the strain tends to lift them out; which at once points out the necessity there is for attending to this point very carefully.

484. We shall now suppose that we have the fence finished as far as the post *g*, from which it takes a bend. Now, all the difference in erecting a wire fence upon a bend from erecting it upon a straight line is, that the posts forming the angles of the bend *g* and *i* require to have an extra stay above ground upon the inside of the curve; and every intermediate upright must also have a stay either under or above ground, in order to resist the pressure of the strain inwards; but if the curve be moderate, a stay at each second or third upright may be quite sufficient. In all cases where a gate occurs in the line of a wire fence, that should be made to have the same appearance as the fence itself, putting in the same number of horizontal wires in it that there are in the fence.

485. With regard to the cost of erecting wire fences upon wooden posts, of course the price must in all cases vary according to the strength of the wire used, as well as according to the height of the fence to be erected. As we have already stated, there are different sorts of wire used in the erecting of those fences—those wires being known according to their numbers respectively, as shown in fig. 23. In putting up a fence, the kind of wire with which to erect it must in all cases be determined by the circumstances—the heavier sorts being used where there will be heavy pressure on them, and the lighter sorts where there are only sheep and small cattle.

486. The prices of the different sizes of wires can be had on application to any of the manufacturers of wire fencing, together with estimates for the erection of the different kinds of fences, so that in a

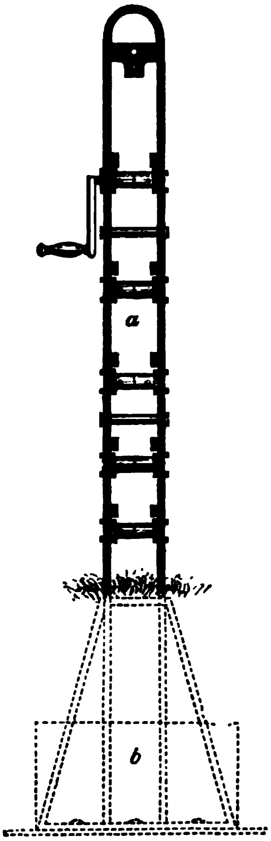
work of this kind it is not necessary for us to mention the cost of material and erection. It must also be kept in view that the price of the wire is at all times regulated by the market-price of iron, which is subject to fluctuations.

487. The galvanised strand or rope-wire, as shown at fig. 24, makes an excellent fence on wooden posts for either sheep or cattle, as it is tougher and stronger than the best solid wire, and we would therefore strongly recommend it to be used where a really efficient fence is wanted to resist heavy cattle, &c.

Wire fences erected on iron straining-posts, with wooden intermediates.

488. We have next to advert to the erecting of wire fences on iron straining-posts, with wooden intermediate ones; but as we have said so much in reference to the erecting of those entirely on wood, it is not necessary that we should enter minutely on the subject of putting up this class, as the only difference in dealing with it is the using of iron strainers instead of wooden ones. Under this head, therefore, our remarks will be confined chiefly to a description of the iron strainers in use and the mode of erecting them—the intermediate posts being dealt with in all respects as described in regard to the erecting of the wire fences entirely on wooden posts.

Fig. 39.



489. Iron straining-pillars are a great improvement in wire-fencing, not only because they are more permanent than wooden strainers, but also because the fence can be more easily and more neatly put up with them than with the other—especially with the use of those fitted with the winding apparatus. Fig. 39 shows an iron straining-pillar fitted with its winding apparatus, and a handle for winding. This description of strainer is manufactured and sold by Messrs A. and J. Main & Co., wire merchants, Glasgow, London, and Dublin. They are made of cast or of wrought iron, as may be wanted by parties, according to taste—the wrought-iron ones being lighter-looking than those made of cast-iron. They are made either with single or double

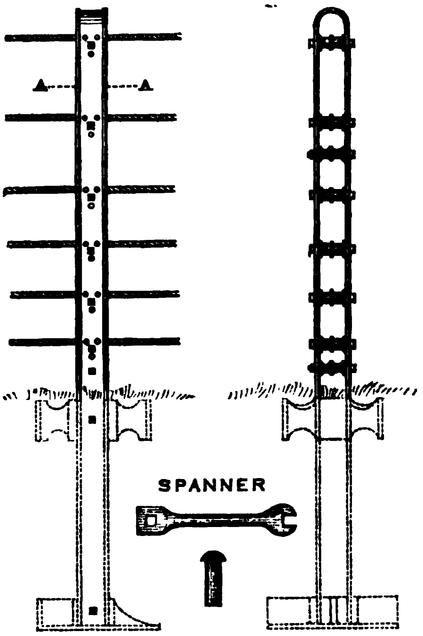
winding action, as may be required for special purposes, the one shown in the figure being of double action—that is, the barrels *a* are all double, and therefore the wires can be strained from both sides by the same pillar; and by means of this double action half the number of strainers usually required is sufficient for the straining-up of a fence, and this forms an important saving in fencing by their use. One of these double-winders fixed at every stretch of 500 or 600 yards in the line of a fence is found quite sufficient for perfect tension, whereas one single winder would be required for every 200 yards. From the figure it is seen that these straining-pillars are made with very large bases, *b*, which secures them firmly in the ground.

490. At the beginning or termination of a fence it is not necessary to use a pillar of double-winding action, but of single action only, as in such a position the winding is only necessary from one side. Therefore, in erecting fences with these winding-strainers, those having the double action are used only where the straining is required from both sides, while one with a single-straining action is used at the beginning and at the end of a wire fence. Indeed, many use the double-action strainers only in the middle parts of a fence, and only a common iron post at beginning and ending, to which the wire is merely fixed in the usual way; and for all practical purposes such a post answers perfectly, as all the straining can be made from the second post from the end, which of course should be one of double action, fitted to draw up the wire from both sides when that is necessary. The erection of a wire fence by means of these straining-pillars with winding apparatus is so extremely simple, that really little or no explanation is necessary beyond what we have already said. The pillar is securely fixed in the earth by means of its own attached iron base, and supported against the strain from the next pillar by an iron stay, which has also an iron base attached to it; and erected firmly in this way, the ends of the wires are next attached to the respective barrels, by being passed through the holes in them for the purpose, and afterwards wound up to the desired tension by means of the handle.

491. Besides the foregoing description of double action straining-pillars for wire fencing, there are several others, now very much in use, from which a choice can be made. There is one manufactured by Messrs Bayliss, Jones, & Bayliss, Victoria Works, Wolverhampton, and called the "Victoria" single and double action straining-pillar. Fig. 40 shows one of these double action pillars with its various parts. They are very strong; the frame is made of wrought-iron, and they will strain from 500 to 1000 yards. The double pillar, the principle of which is shown by the above figure, strains the wire on each side in the

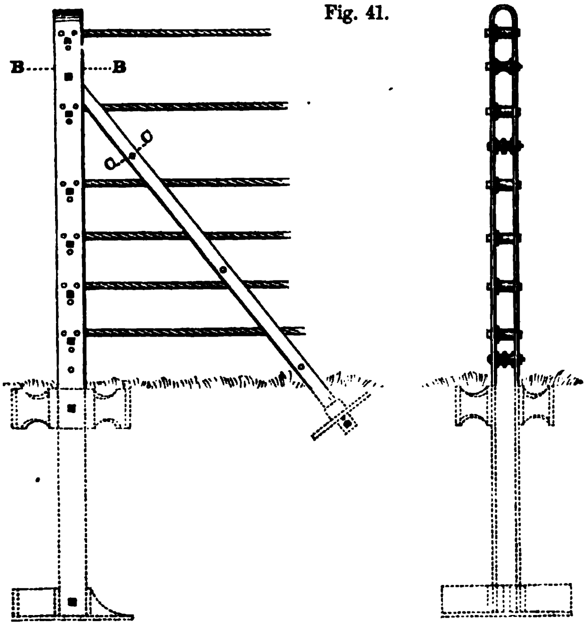
same horizontal line, either in a straight line or at an angle. The two rollers have a common spindle, and revolve independently of each other. Holes are bored in the side frames for the rollers to work in, and the rollers being placed between the two side frames, these are bolted together with distance pieces between, and the pillar is complete. The construction of the pillar is so simple, that any labourer can erect the fence: the ends of the wires are passed through the hole in the roller, and when sufficiently strained a pin is passed through one of the holes on the side to one corresponding in flange of the roller, which is thereby securely held in position.

Fig. 40.



492. The principle of the single pillar, manufactured by the same firm, is shown in fig. 41. Both these straining-pillars are ex-

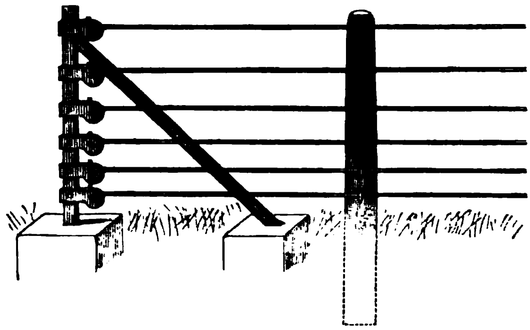
Fig. 41.



cellently adapted for straining long lengths of wire fence, and are constructed on a strong principle, and possess the latest improvements. The figures speak for themselves, so that further explanations are unnecessary in regard to them.

493. There are other straining-pillars, of a much similar construction, which can be had from any of the fencing manufacturers; but the two which we have mentioned are sufficient in order to show the principle upon which they work. Their use does not add to the cost of the fence; but from the greater length they strain, lessens the cost as compared with wooden strainers. It will be readily seen and understood that these double pillars do not require any stays when the line of fence is straight—the wires pulling in opposite directions keeping them perfectly erect and steady.

Fig. 42.

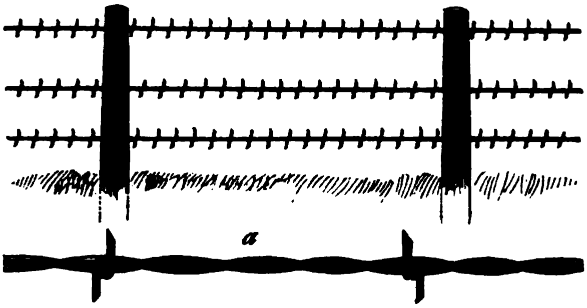


494. Fig. 42 shows another form of straining-pillar, manufactured by Mr William Hume, iron-manufacturer, Glasgow. It is called the iron ratchet straining-pillar, and the one as shown in the figure forms the extreme end of a wire fence with wooden uprights; but they can be had to strain both ways in the centre of a fence, in the same way as those already mentioned. Their construction is quite simple, the ratchets being attached to the post by plates bolted on each side, and they can be tightened up or slackened by the key at any time. They are batted into stone, and have a strong iron stay when the strainer is at the end of a fence or at an angle. The one shown in the figure being at the end of a fence, and straining only from one side, has a stay which is also batted into stone in the usual way. This kind of straining-pillar can also be had with self-fixing bases, which obviate the necessity of any stones whatever.

495. Under this department of wire-fencing we may mention a fence which has only lately been introduced into this country from America, but which has not, so far as we are aware, been tried here to any extent. We refer to the American barb fence,—one which is rather peculiar in its construction when compared with our commonly used wire fences. Fig. 43 will give an idea of this kind of fence. It can either be erected on wooden or iron straining-posts, with wooden intermediates; the straining-posts being the same as those used for a

common fence with iron strainers and wooden intermediates, as already described.

Fig. 43.



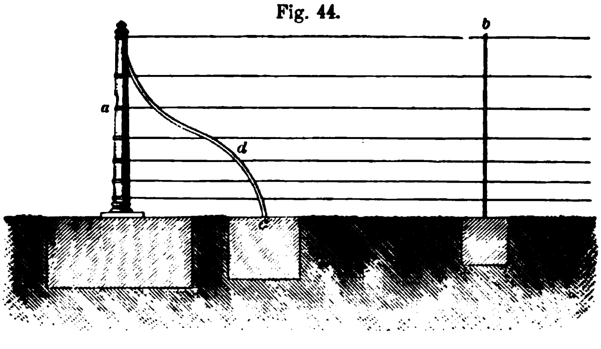
496. This new fencing material is steel, and is composed of two strands, with *barbs* projecting at right angles every few inches, as at *a* on the figure. Three lines of this barbed strand are usually found sufficient for a fence of ordinary height, as cattle will not attempt to get through after once coming in contact with the fence. A strand wire of this kind might be used as a top wire in an ordinary wire fence with effect, or with a second line in the middle of the fence. The wire is supplied in "spools" of about 400 yards in length, and can be fixed with the ordinary staples. All the materials for a fence of this kind can be had from Mr William Hume, iron-manufacturer, Glasgow; who also supplies a newer form of fencing-wire of similar description, but which is said to be less likely to hurt animals, as the barbs are within an inch of each other. With regard to this barbed fence, we cannot say anything from experience, but merely mention it as one which has lately been introduced into this country. It has the disadvantage of being dangerous to animals coming in contact with the fence, and on this account chiefly we are disposed to think it may not meet with much favour in this country.

Wire fences erected upon iron straining-pillars, with iron standards.

497. We now come to refer to the putting up of wire fences upon iron posts or uprights. But having said so much relative to putting up the two classes of wire fences referred to in the foregoing part of this section, it will not be necessary for us to enter into detail upon the erecting of iron ones, seeing that they are put up upon the same principle as the others. We will therefore only state under this head what we consider peculiar to this class as compared with the others, mentioning at the same time the most approved kinds of fences now erected.

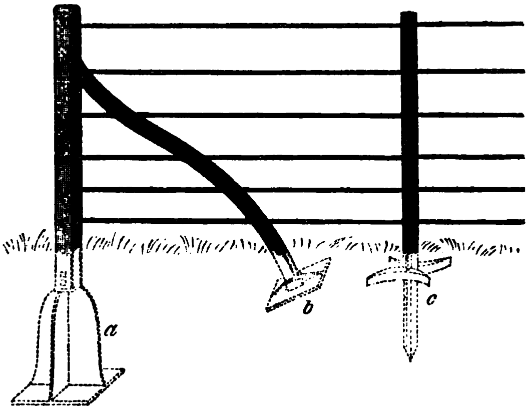
498. Fig. 44 represents a wire fence upon iron uprights, having 7 horizontal wires, and 4 feet high. The straining-pillars are generally of wrought-iron, 1½ inch square, and are placed at 100 yards apart in the line of fence, with stays for the ends of the fence; but they may be made of cast-iron, and round, as shown in the figure. The straining-post, *a*, is sunk and batted well into a large stone, which should be at least 3 feet square on the surface and 18 inches deep. The stay, *d*, is also well sunk and batted into a large stone, 18 inches square and 15 inches deep; and in putting in these stones, they should be firmly bedded into the ground, so as not to yield afterwards by the strain of the wire. The stay is of double iron, for allowing the wires to pass through between each piece; and the standards, *b*, are 1½ inch by ⅜ inch, and placed at 6 feet apart, and also sunk into stones about 12 inches cube. This fence will resist the heaviest stock, and is manufactured by G. B. Smith & Co., iron-manufacturers, Glasgow.

Fig. 44.



499. It is not absolutely necessary that the description of wire fences now under notice should always have the straining-pillars and standards sunk and batted into stones; as now, with iron bases and earth-plates fixed to them, a fence equally strong can be put up without their use. A reference to fig. 45 will at a glance show how the stability of the fence is secured without the use of stones. In the figure, the base of the terminal straining-pillar is shown as

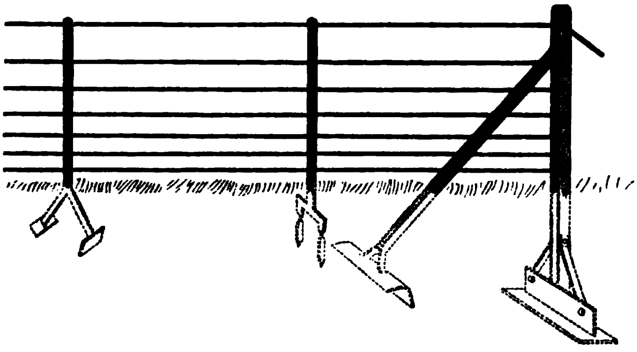
Fig. 45.



sunk in the ground at *a*, and that of its stay at *b*. The base of the standard, which is shown at *c*, consists of what is called a cast-iron earth-plate. This fence is 4 feet high, and has 6 lines of galvanised strand or rope-wire. It has a patent winding straining-pillar with self-fixing base every 200 yards, and strong T-iron standards every 9 feet, with cast-iron earth-plates, already mentioned. This fence, together with many others constructed on a much similar principle, is manufactured by Messrs Bayliss, Jones, & Bayliss, Victoria Works, Wolverhampton. We have of late seen considerable extents of iron fences erected on this principle, and find them as strong and secure as those with all the uprights batted in stones.

500. Nor is it in all cases necessary to have the intermediates made with self-fixing bases or earth-plates, as an equally strong fence can be made with double-pronged intermediates. Fig. 46 shows a good substantial fence, 4½ feet high, with 7 wires, the standards being placed 8 feet apart, and made of 1½ by ⅜ inch wrought-iron, having double-pronged and anchor-formed self-fixing feet alternately. The straining-pillars, which are also of wrought-iron, fitted with improved winding-gear, have double stays, all with self-fixing bases, and are placed 100 yards apart. This fence is adapted for heavy stock and the most exposed situations. It is manufactured by Messrs Hill & Smith, Brierley Hill Iron-Works, near Dudley.

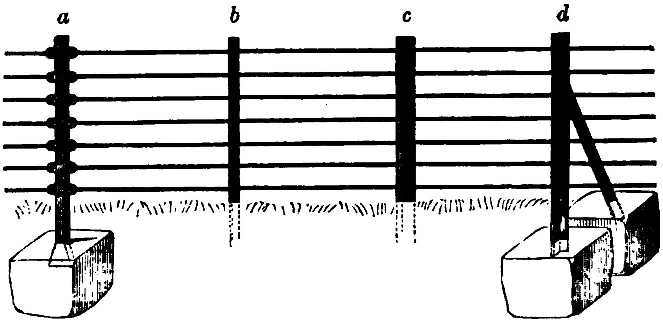
Fig. 46.



501. A very efficient system of iron-fencing has within the last few years been introduced into this country from New Zealand, and is now known as the "Corrimony" fence (see fig. 47). The difference between this fence and an ordinary strained wire fence is as follows:—The Corrimony fencing consists of wrought-iron winding straining-pillars and solid resisting pillars, placed alternately on an average of 9 to the mile; iron standards, which have stays attached to them, are placed generally about 18 yards apart, and the

horizontal wires in connection with these are made of steel, and are of sizes varying according to the required strength of the fence. Threaded upon these wires, and between the standards, are what are called "droppers," or intermediate uprights, placed 6 feet apart. They are not fixed in the ground, but hang upon the wires, and barely touch the ground, and are either made of light iron or of wood. When made of iron, they are fixed to the wires with iron wedges; or if made of wood, they can be fixed on the wires with staples, or have holes bored in them for the wires to pass through, and be secured with wooden wedges. The accompanying figure will illustrate this

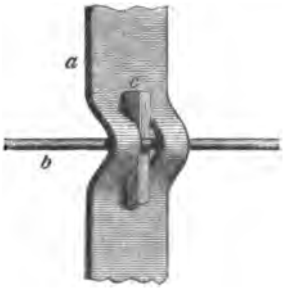
Fig. 47.



system of iron-fencing more clearly. The fence, as there represented, is manufactured by Messrs Hill & Smith, Brierley Hill Iron-Works, and is 4 feet in height, with 7 lines of wire, T-iron standards 18 yards apart, droppers 6 feet apart, and straining-pillars averaging 180 yards apart. In the figure it will be noticed that there is shown both an iron dropper, *b*, and a wooden one, *c*. This is merely for the purpose of illustrating how these are fixed on the wires; and in putting up the fence, if the proprietor prefers to have those made of wood, they can be put on, made of wood to be provided by him. It will also be seen that the straining-pillar, *a*, and standard, *d*, are both batted into stones, but in some cases they are made with self-fixing bases. In a fence of this kind it is particularly necessary that both straining-pillars and standards be very securely fixed in the ground, seeing that they are so far apart as compared with other fences.

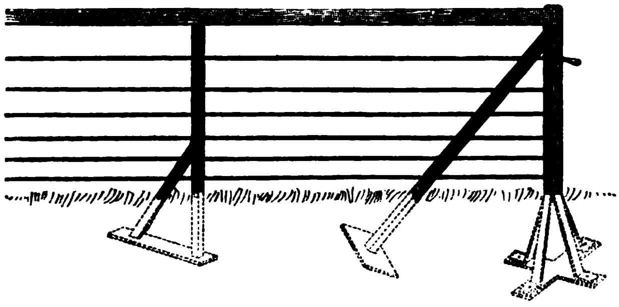
The ordinary form of "droppers" used in the Corrimony fence require to be put on the wires before the fence is strained, but of late an improvement has been effected in their construction by the invention of droppers which can be fixed upon the wires *after* being strained, and which at the same time are not liable to be displaced by cattle rubbing themselves against the fence. Fig. 48 shows how this dropper is fixed to the wires. It requires no explanation from us, further than that the dropper, *a*, is merely placed on the wire, *b*, and is securely held in its place by the wedge or pin, *c*, which effectually prevents the dropper from slipping along the wire. By this arrangement the dropper may easily be taken off or replaced when necessary. The one shown in the figure is invented and patented by Messrs G. B. Smith & Co. of Glasgow.

Fig. 48.



This fence has been thoroughly tested in many parts of Scotland, and has been found well adapted for various kinds of ground. We have seen it erected in very exposed situations, and also in the home grounds surrounding country residences, and we can confidently say that, as a fence either for home policies, or for hilly and outlying districts where cattle and sheep are grazing, it ought to be more extensively used.

Fig. 49.

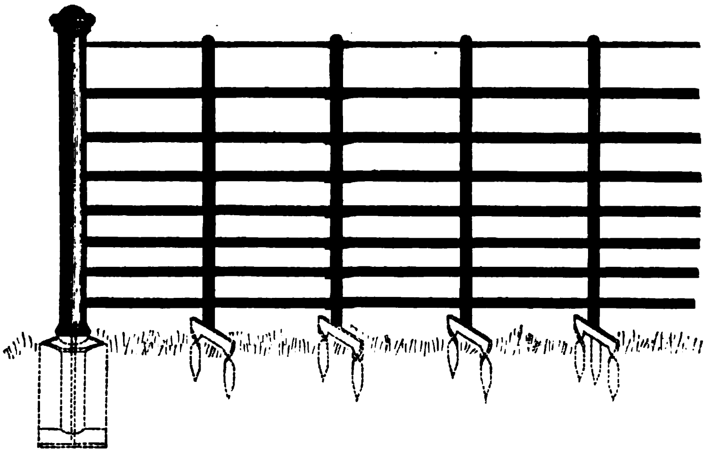


502. We have heard wire fences objected to on account of their being dangerous to horses leaping over them. This objection is raised chiefly in districts where fox-hunting is followed, as accidents are very likely to occur in leaping. The wires on a fence of this kind are not readily seen by horses; their feet often get entangled in the wires, and the consequence is that the rider is thrown off. In such a case a very suitable fence can be formed by having a larch rafter on the top, instead of a top wire. A fence of this kind is shown in fig. 49. It is 3 feet 9 inches high above ground, has 6 lines of wire, with a larch rafter on the top of the fence, which should not be less than 3 inches by $\frac{7}{8}$ inch. The standards are of angle-iron, and are placed at 7 feet apart, and 18 inches under ground; while the straining-pillars are on the self-winding principle, and placed every

200 yards apart. These have self-fixing bases, as shown in the figure. Of course the number of wires can be determined according to the height of the fence, or even the fence can be made with a top wire as usual, and the rafter put on or taken off when necessary. The fence in the above figure is supplied by Messrs G. B. Smith & Co. of Glasgow.

503. There is yet one fence to be referred to under this heading —namely, the continuous wrought-iron fencing. This kind of fence is now so generally known in the country, that it is hardly necessary for us to give any lengthened description of it here. It is manufactured of different heights, to suit various purposes; but by referring to fig. 50, which represents a fence of this description suitable for deer-parks, a sufficient idea of its construction will be formed. This deer-fence, as there shown, is made by Messrs Hill & Smith of Brierley Hill, near Dudley, and has 8 bars, the top one being of round iron ¾ inch diameter, joined in every fourth standard by means of an improved ferrule joint; and the others flat iron, 1 inch wide by ¼ inch thick, placed with their edges downwards, and connected together by means of an overlap notched joint. The standards are placed 3 feet 9 inches apart, and are made with double-pronged feet; the size of the standards at which the horizontal bars join is 1¾ inches wide by ⅜ inch thick, while the intermediate ones are 1½ inch wide by ⅜ inch thick. The whole fence is 6 feet high above ground, and 18 inches below. This is a very durable fence, and one great advantage which it possesses is that it can be easily fixed in curved lines, and can at any time be taken up and removed to another place with little trouble. It does not require any side stays, neither

Fig. 50.



does it need stones or wooden blocks, nor do holes want to be dug in erecting it. It is preferable to wire-fencing for the divisions of deer-parks, owing to the readiness with which it can be removed, and its being more easily seen by stock of any kind, thus causing much less danger than a common wire fence would if used for the same purpose.

504. We have already mentioned that fences of this sort can be had of various heights. If preferred, the whole of the bars can be made of round iron, like the top one in the figure we have shown; or the top one can be made of square iron, according to taste and circumstances. A fence of this kind, 3 feet 9 inches high, makes an excellent one for cattle and horses, while one of 4 feet or 4½ feet high will resist the heaviest stock. For pleasure-grounds and other situations they are made with a turnover top, and with a chain on top, instead of a wire. In short, there are so many different patterns of this continuous fence, that to enumerate and describe them all would take up too much of our space, and at the same time would serve little practical purpose.

505. When a fence is required to be made game-proof, or to serve the purpose of protecting young plantations of trees from hares and rabbits, wire-netting is put on along the bottom, generally to the height of 2½ or 3 feet. The size of mesh most suitable for making a fence game-proof is 1½ inch, but of course it can be had of any size. It can be fixed on any wire fence, and should have about 3 inches put below the ground, in order more effectually to prevent rabbits burrowing under it. The price of this netting varies according to the height and size of mesh, but it can be had on application from any of the manufacturers of iron fencing.

506. Regarding the cost of material and erection in putting up wire fences entirely made of iron, as there are so many catalogues of prices and other particulars yearly issued by all the chief makers, we think it unnecessary to say anything on that point here.

507. Having referred to all the principal kinds of wire fences erected upon iron straining-pillars and intermediates, we have in our descriptions of these mentioned all the difference worthy of notice between the erecting of a wire fence upon iron posts and one upon wood. In the actual erecting of the two the same implements are used, and the same method of working from beginning to end is pursued. Having said, therefore, so much upon the method of erecting fences upon wood, it is quite unnecessary for us here to say much more, as it would merely be a repetition of the same thing. The only difference is, that in the erection of a wire fence upon iron posts, these are either sunk into stones, or have self-fixing bases or double-pronged feet. When stones are used, they should all be covered with

about 3 inches of earth. Another difference, as we have seen by the foregoing description of the fences, is that the wires upon an iron fence are run through holes bored in the iron uprights or standards, instead of being fixed by staples, as is the case in the wooden posts. In order to prevent strong animals from pressing the iron uprights to a side, they are often what is termed *wedged*,—this being done by inserting a small iron wedge, or nail without a head, into two of the holes in each standard, say one at the top wire and one in the middle, and immediately above the wire. This should not be done, however, until the standards are made perfectly plumb and the fence finished, when the wedges should be driven in firmly; but at the same time they ought to be put in so as they can be readily driven out again at any time when the wires require to be re-strained. In all wire fences with iron standards, where curves occur in a line, it is also necessary to have iron stays put to the standards on the inside of the curve and against the strain.

508. In erecting wire fences wholly on iron uprights, the winding and straining pillars are usually placed in the middle of the line when there are long lengths to put up; and in applying them to this class of fences, the work is performed in all respects as has been described in reference to the fences with iron strainers and wooden intermediates.

509. We may further add, that all wire fences, whether upon wooden or iron posts, should have the iron-work painted each year for the first two years after being erected; after that period each second year will be enough. Black varnish is now extensively used for that purpose, and proves a very good preservative for iron fencing. In the summer time the wires of all these fences are apt to expand in warm weather, and consequently become slack: in such cases the screwed eye-bolts or the winding-rollers, as the case may be, should be put in operation to have them tightened up again. In the winter season, particularly during frost, the wire always contracts to a considerable extent, causing the wires to become over tight, and consequently in such cases they require to be slackened. These things we have experienced so often, that we think it proper to refer to them here, because if these points be not attended to, the wire will break in the winter and sometimes allow cattle to escape, and become too loose in summer. However, we may mention that a great deal of trouble of this kind is caused owing to the fences being made of inferior wire. All good wire should tie cold—that is, it should knot without being subjected to any heating in a fire. A really good fence that is put up with good wire will not give a great deal of trouble, either in the way of straining or in being subject to breakages.

510. With regard to the most suitable material for batting iron

standards into stone, we are of opinion that either lead or what is called *lava cement* should be used. Lead has been used to a great extent in most parts of the country, and has given satisfaction in nearly all cases. It has the disadvantage of being costly, however; and if the hole is not properly filled, the standard may become loose. Good lava cement is a capital substitute for lead, and we are not aware that it injures the iron in any way, as sulphur often does. This substance sets very quickly, is very hard, and is in our opinion as good a material for batting iron standards into stone as can be had. Of course, whatever kind of batting material is used, the fence should get all justice by being well kept free of rust, as much harm is often done to an iron fence by rust, the cause of which is generally attributed to a bad batting material. Straining-pillars should generally be sunk 5 inches, stays 4 inches, and standards 3 inches into the stones; but as much depends upon the quality of the stone and the size of the standards or straining-pillars, this must be decided by the circumstances of each case.

511. From extended experience in the erecting of wire fences, we are now decidedly of the opinion that they should be all put up on iron straining-pillars, of one or other of the kinds described in the foregoing parts of this section. Wherever this mode has been adopted, the fences answer admirably, both for strength, durability, and neatness of appearance. In fact, a wire fence put up on this principle may be truly said to be almost indestructible by time, if properly attended to and kept in order, as, although the intermediate posts may be of wood, and should rot and give way, yet the iron strainers remain as they were when put up, and therefore the wooden posts of the fence can be easily removed at any time, and new ones put in, when the whole will be as good as when new. Although a wire fence erected on iron straining-pillars, with wooden intermediates, is as suitable a one as can be had for resisting heavy cattle, yet fences of this description are now generally being superseded by those erected wholly of iron. As we said at the beginning of this section, we may repeat here, that this may be truly said to be the "iron age." Fences erected entirely with iron have certainly a neat appearance when compared with those with wooden intermediates, and have likewise the advantage of lasting for a far greater length of time without requiring repairs. Although to a proprietor who has plenty of good larch timber of his own at hand, with which he could readily put up a fence with wooden intermediates, an iron fence may seem expensive at first putting up, yet it will be found that in the end it will be the cheapest fence. Looking at the price of timber, it will be found that, even when newly erected, there is little difference between the two. Iron fences can also be made to stand as much pressure from cattle

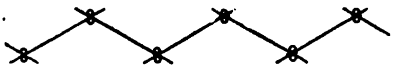
as those with wooden intermediates; so that, taking everything into consideration, we are of opinion that wire fences entirely erected of iron, both straining-pillars, standards, and stays, are most suitable for general practical purposes.

512. Having thus given our opinion on the subject, we leave the choice of the use of wood or iron to individuals themselves, as they may find the one or the other most suitable for their own purpose. In the foregoing section all the principal wire fences that are of any consequence will be found described; and whichever is found most suited to any local circumstances can be decided upon by those wishing for any information on the subject.

SECTION VIII.—KIND OF FENCES GENERALLY USED IN THE UNITED STATES OF AMERICA AND IN THE BRITISH COLONIES.

513. In nearly all of the agricultural districts of the United States of North America wooden fences are used for the enclosing and subdivision of fields, and these are chiefly of two sorts—viz., the zig-zag rail fence, or snake fence as it is sometimes named, and the board paling fence. The zig-zag fence is formed of rails about 4 inches in diameter, each 12 feet in length, and laid thus along the whole line of fence (see fig. 51). In this way the rails are built the one upon the other in layers, continuously, till the desired height is obtained; which is generally about 5 feet. In order to keep the rails of which this description of fence is formed secure in their places against the pressure of cattle, two strong stakes are fixed upright into the ground at every corner, one on each side, and each pair is brought to bear firmly into the angle on which it stands; so that when they are properly in their place the top of the fence at every corner is closely embraced by the upright stakes on each side, and the tops of each pair form an angle above and on the line of fence. Into the angles thus formed by the stakes at each corner, a rail is placed continuously the whole length of the fence, and this line of rails keeps all the stakes firmly in their places, while these again embrace the rails under them so firmly that cattle cannot easily misplace or remove any part of the structure. This sort of fence is in general use in almost all parts of the United States where wood is plentiful. It takes up much useful land, however, as it needs about 6 feet in breadth along the whole line of fence to stand on, and therefore is objectionable on that account.

Fig. 51.



514. The board paling fence is a great improvement compared with the one just referred to. It consists of strong posts, put 3 feet into

the ground, and 6 feet apart on the line of fence. On these four boards are nailed,—the lower one 12 inches broad, and placed nearly close to the ground, in order to keep back small animals, such as pigs; the second board from the bottom is 8 inches broad, and placed about 5 inches above the one under it; the third board is 6 inches broad, and placed 6 inches above the second; and the fourth board is also 6 inches broad, and placed 9 feet above the third; and the fence is thus made about 5 feet in height over all. The boards of this sort of fence are generally sawn 1¼ inch thick, and when well put up and firmly put together it makes a substantial fence, and will last for a considerable number of years.

515. Of late years however a great extent of wire fences has been erected in the United States,—and these chiefly on grazing farms on the Prairie and Western States, where timber is scarce and high priced.

516. In parts of the United States where stones are abundant, stone walls are generally erected; and we often see these of a very substantial structure, and even with wire fences on top, in all respects forming fences of a first-rate character.

517. Hedging has hitherto been much neglected in all parts of the Union; and chiefly, we presume, from the expense that this class of fences entails in the first stage of management. This is a short-sighted policy, however, as hedges, when once properly established on an estate and skilfully managed, will stand good against several successive wooden erections as fences; and, besides, will produce a degree of shelter and clothedness never to be obtained from palings of any description. Hedges are to be found on many parts of the States, however—but, generally speaking, only on the properties of the wealthier and more intelligent farmers, who have observed the advantages arising from this class of fences to their stock and crops. We would here, therefore, recommend North American farmers to take into consideration that wooden fences are only of a temporary nature, and give little or no shelter to their lands; while hedges, when well managed, last for generations, and produce much shelter to their subjects—causing their fields to produce early crops, and preserving the herbage to the latest period possible in the fall of the year.

518. With regard to fences in Canada, they are generally of the same descriptions as those referred to in respect to the United States. Here the general fences used are the zig-zag or snake, the board fence, and on parts stone walls; while hedges are to be found only here and there, on the farms of the more intelligent and wealthier classes. Wire-fencing has been introduced here to a considerable extent of late, and this class of fences seems to gain ground rapidly, as we have

observed many of such in various parts, and these are generally well put up where they exist.

519. In Australia and New Zealand wire fences are extensively used for enclosing sheep-runs, as here wood is scarce on many parts of the country, and for this reason wire fences are found cheaper in the first erection than wooden ones. Where wood is plentiful, however, fences of this material are in common use, and of various designs, but chiefly of the horizontal barred description. Here also hedging is neglected, but we are informed that some of the farmers are now planting them on a small scale, with various sorts of plants.

520. In South Africa fencing is much in the same position as it is found in Australia. Here the open sheep-runs and agricultural farms are enclosed chiefly by wire fences; while in the neighbourhood of woods and plantations palings of various designs and descriptions are in use.

SECTION IX.—THE PURPOSE AND SITUATION FOR WHICH EACH SORT OF FENCE IS MOST PROPERLY ADAPTED.

521. Having now given in detail the method of erecting the most common and generally useful fences for country purposes—namely, the thorn hedge, the furze hedge, the stone-and-lime wall, the dry-stone dyke, the turf dyke, wooden paling, and wire fence both upon wooden and iron uprights, and also given a description of some of the plants used in hedging besides the thorn, beech, and furze—it still remains for us to point out in what situation, and for what purpose, each of the above-named fences is most suitable. In the present section we shall endeavour to do this, and shall commence with the first in order —namely, the thorn hedge.

522. For the subdivision of strong clay and heavy, loamy, arable lands, we think that no fence is so suitable, whether in respect to neatness, clothedness, or duration, as the thorn hedge, as in such soils it lives long, becomes strong and healthy, and makes an admirable fence.

523. The thorn hedge, with a mixture of beech-plants, is of all other fences the best adapted for a situation where a neat and clothed appearance is the object; and this it always has unless carried to a situation more than 1000 feet above the level of the sea, and unless at such an altitude planted in a mossy or light soil; for there it will not live long, except upon a loam.

524. In high and exposed situations, hedge fences are excellently adapted for the division of fields; and even in such situations, no fence ultimately answers better than the beech hedge; for such a

fence, although on a light soil and high exposure, under careful management, will keep good and be an ornament when dykes and palings of the same age are tumbling down and useless. We are aware that many object to the raising of hedges with beech and thorn in high parts of the country, asserting that the thorn does not succeed. As to this, we can affirm thus far, that upon many estates we know there are good hedges of beech and thorn more than 900 feet above the level of the sea, and at the same time in excellent health. In very high parts, however, and on very light lands, a better fence is secured by using beech alone than by mixing with thorns, as the beech is not only hardier, but better adapted to grow healthily in high lands.

525. Second, The *furze hedge* is unquestionably one which should be kept out of all cultivated districts. There is no situation where the furze is found growing as a fence, in which beech would not thrive much better.

526. Third, The *stone-and-lime wall* is of all others the most substantial fence that can be erected; but as it is an expensive one, it cannot properly be carried to any great extent. However, no landed proprietor's policy-grounds can be said to be complete, as regards general security, unless they be surrounded by a stone-and-lime wall of from 6 to 8 feet high. In fact, a park surrounded by a good high wall gives us a confident feeling that there is something within the bounds of it worthy of being protected; and we always find the best of seats surrounded by such. But in no other case is it necessary to erect a stone-and-lime wall as a fence, unless in the case of sunk fences. In a former section, when referring to the making of sunk fences, we said that they were only adapted for a particular situation—namely, upon the slopes of rising ground; and by no means upon level ground, —for there, if it is desired to have an invisible fence—as the sunk fence is meant to be—the wire fence is infinitely superior in every respect, and is now at the present day what sunk fences were a hundred years ago. A sunk fence is excellently adapted for any purpose whatever, when built upon the slope of a hill or brae, as shown in Section II. of this chapter; but in any other, we are not aware of its utility.

527. Fourth, The *dry-stone dyke*, of all other fences, is the best adapted for giving immediate shelter to young plantations and other crops upon high and exposed parts of the country. Unlike any other fence, it is both a fence and a shelter at once; hence the reason that it is so much in request in all bare uncultivated districts.

Dry-stone dykes are, from their outlandish appearance, not to be recommended as a fence where a fine effect is meant to be kept up, therefore they should not be built near the home-grounds of a landed proprietor; but upon high-lying parts of the country, where improvements are in infancy, no fence is more commendable, both as regards security and shelter.

528. Fifth, The *turf dyke* should never be made use of except on high-lying moorland districts where stones are not easily got at, and where immediate shelter is wanted for sheep stock. From the temporary nature of the material of which it is made, it is constantly liable to injury by all kinds of heavy cattle, consequently it should not be erected where these are to be grazed. The only parts of the country where the turf dyke can be at all recommended is on high-lying sheep-pastures where shelter is wanted for the stock, where stone dykes cannot be easily erected, and where wire fences are objectionable on account of their producing no shelter.

529. Sixth, *Wooden palings* are, in general, only considered as temporary or assistant fences. In all cases where young hedges are planted, and where cattle of any description are to be grazed in the fields adjoining, they must be protected by a wooden paling until they have attained a size and strength sufficient to insure their being exposed with safety; and this is one use for which palings are in continual demand.

The horizontal paling is used principally for agricultural purposes, such as the protecting of hedge fences in their young state, or for the mending of gaps in old hedges, &c.; but the upright paling, as well as an endless variety according to the taste of parties, are mostly used as ornamental fences about gardens, cottages, &c., and they form excellent and useful fences when made of good larch-wood, which will last longer than any other sort for this purpose.

530. Seventh, The *wire fence* is of all others the most durable and ornamental, and at the same time the cheapest. It takes up scarcely any space between enclosures, and therefore is of all fences the most suitable for agricultural districts. Of course it is not capable of producing any available degree of shelter; but where this is no object, the wire fence should be used in preference to any other. As a fence for young plantations it is now extensively used in all parts of the country, even in high-lying districts; and where the plantation is extensive they answer the purpose perfectly, because in this case the trees soon give shelter to each other, and do not require it from a fence; but in the case of small plantations they thrive better when protected by a fence calculated to produce shelter at once, such as a stone dyke. The wire fence on wooden intermediates, with improved iron straining posts, is the best adapted for all agricultural and woodland purposes, as the wooden intermediates are not apt to be in any way disturbed by the pressure of heavy cattle. Where the greatest possible degree

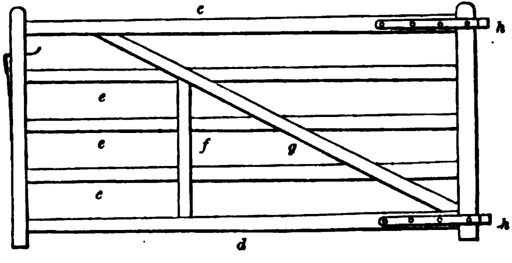
of invisibility is wanted, however, as well as the greatest possible degree of permanency as a fence, the wire fence wholly on iron uprights should be used, as this sort, when painted green, is not observable by a person till within a few yards of it, and will last, if well attended to, for a great length of time.

SECTION X.—THE MAKING AND HANGING OF GATES UPON FIELDS AND PLANTATIONS.

531. As the making and hanging of gates is a branch of rural economy most frequently devolving upon the forester, we consider it necessary, and of importance, to dedicate a section to the explanation of the most approved method of making and hanging field and plantation gates; and moreover, having said so much upon the nature of fencing in general, this chapter would be incomplete without a few observations on this point.

532. Every field and plantation of any consequence must have one or more entrances into it, in the form of openings in the fence which surrounds it, and which again must be made to act either as a fence or as an opening, as occasion may require. These openings are termed gateways; and whatever may be put upon them to act as a fence is termed a *gate*. There are many forms of gates in use in different parts of the country, from the most rude horizontal spar, made to fall into a post at each end, to the fine massy iron gate hung upon hinges. It would be entirely out of place for us here even to attempt to enumerate the many different sorts of gates that may be considered of useful designs; we shall therefore confine ourselves to the description of two sorts of field-gates—the one made from wood and the other from iron—which are, in our opinion, the best possible adapted for plantation-gates, and which we consider the most complete for all field and plantation purposes. We shall, in the first place, describe the one made from wood, of which fig. 52 is a sketch. Gates of this construction are now extensively used in many parts of the country, and are generally made of the best old larch-wood, or the best old pine, which, when painted, lasts for a great number of years. As larch-wood, however, is very apt to twist in the heat of the sun,

Fig. 52.



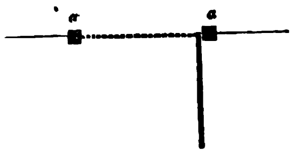
to which it is exposed when converted into a gate, it ought to be well seasoned before being used for this purpose. The following are the dimensions of the gate referred to in fig. 52. The back post *b* is 5 feet high from bottom to top, and the scantling 4½ by 2½ inches. The front post *a* is also 5 feet high from bottom to top, and the scantling 3½ by 2 inches. The bottom and top horizontal bars *c* and *d* are each of equal dimensions—namely, length within the back and front posts about 9 feet. These are 4 inches broad at the joinings upon the back post *b*, and 3¼ inches broad at the joinings upon the front post *a*, by 2½ inches thick. The horizontal intermediates *e e e* are of course of the same length as the bottom and top bars, and of the same breadth, but they are only 1½ inch thick. The diagonal bar *g*, which reaches from the heel of the gate to within 18 inches of the point of the top bar, is of the same strength as the upper and lower bars, and, like them, tapering from 4 inches at heel to 3¼ inches at point; and the upright piece *f* is of the same dimensions as the intermediates, and reaches from the bottom bar to the diagonal at its junction with the second bar from the top. This gate is furnished with double hinges, which greatly strengthen the back part by clasping the joints both at bottom and top, *h h*. See fig. 53, which is a representation of this double hinge. The peculiar properties of this form of gate are,—first, the back post *b* is much heavier than the front one *a*, which tends to throw the centre of gravity upon the hinges; second, all the horizontal bars, from bottom to top, are made heavier behind than in front, and all with the intention of lightening the gate in front, and throwing the centre of gravity as much as possible upon the hinges; and, third, the diagonal, *g*, is so placed that it acts completely the part of a lever against any weight that may be thrown upon the front part of the gate; and even its being lighter as it recedes from the heel is a great means of supporting the whole of the gate, and of keeping it in a well-balanced state. It appears to us that any gate made upon these principles must approach the model of perfection in such a structure; and it is upon this account that we consider the gate now described to be of the best description possible, seeing that it combines strength and lightness in a very perfect manner. In making the description of gates mentioned, it is necessary, in order to have them to last as long as possible, to do so from perfectly seasoned wood, and to have them very neatly jointed, planed smoothly, and painted with two coats of oil-paint before being hung; and even after they are hung in their place, they are much improved by being painted at least once in three years.

Fig. 53.

533. We now come to make a few observations upon the nature

of hanging gates upon fences, both in fields and plantations; and as we have frequently seen a great deal of error committed in this branch of the business of fencing, we shall state the manner in which we have all gates hung, whether they are of wood or iron, which is considered by all who have examined it an excellent way of doing the work. The common way of erecting gates is to hang them right between the two posts put up for the purpose; and by this method, when the gate is set open, it stands at right angles with the fence upon which it is placed (see fig. 54, *b*); consequently it is in this state always liable to be injured by carts, &c., coming in contact with it when going into or returning out of the field or plantation. Another evil which almost invariably attends this old-fashioned method of hanging gates is, that from being hung from centre to centre of the two posts, as indicated by the dotted line between the two posts *a a*, when anything goes wrong with either, the gate must be left too slack or confined too tight between them, according to the direction in which the post may have been driven—consequently the gate has a great chance to be injured in some way or other; besides, the posts are seldom put into the ground with the addition of any simple fixture whatever, being merely put into a hole, and the earth again beat down about them; and from this circumstance, if the earth has been put in about the posts in a wet state, the certain result is that they become slack in a short time, when the gate falls down in front, and, in consequence of coming in contact with the ground, is soon either broken or much injured in the joints. Having seen this often happen from bad management, we here recommend the following method of hanging plantation and field gates: Let the post upon which the gate is to be hung be pretty strong—say 9 inches on the side of the square—and let the part of it which is to be put into the ground be left round, and have it put into the ground 3 feet deep, and fixed upon a sole with a diagonal or stay, as has been already advised for wire-fence posts. Having the post made with its sole and stay on the under part, put it into the hole prepared for it, with the sole and stay projecting in the direction of the gateway, which will insure its stability against the weight of the gate or any other ordinary pressure in that direction—and have the post well firmed into the hole: if the earth taken out be of a soft nature, keep it out, and fill up the pit with small stones mixed with earth, or any other thing of a hard and binding nature; and be most particular not to fill in with earth in a soft or wet state, else the work

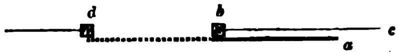
Fig. 54.



will be insufficient, and will not give satisfaction. The post upon which the gate is to be shut may be considerably smaller, if thought necessary, than the other: it will not require to have any sole or stay attached to it, but may very safely be put into the earth at the same depth recommended for the other, observing to make it equally as firm, putting a very large stone or two into the pit near the surface, which will add much to the stability of the post.

Having put the posts in plumb, and at the desired distance, which should always be the exact length of the gate to be put on, next have the *crooks*, upon which the gate is to be hung, put into the post on the angle of the same, instead of on the centre as in the former case. See fig. 55, where the gate *a* is hung upon the corner or angle of the post *b*; the effect of this being that the gate, when hung in this position, has full play upon the hinge to fold back upon the fence *c*, and is not hindered in its motion by the corner of the post, as is the case in the other method; consequently, from the gate having room to fall back upon the fence, it is, when open, entirely out of the way of any cart coming into or going out of the field. Next, instead of the gate being made to shut right between the posts, it ought to be shut upon the face or outside of the shutting-post *d*—this is represented by the dotted line, which shows the position of the gate when shut; and in this case, whatever accident may befall the post upon which the gate shuts, the gate cannot itself be injured. The upper crook of all gates of this description should be made so long as to go through the post, and have about 2 inches of a screw upon the end of it, upon which a large nut, made to fit, is screwed: by this means the crook will keep its position, and will cause the gate to do the same.

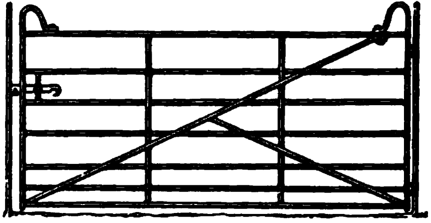
Fig. 55.



534. Many prefer iron gates to those made of wood, both for fields and plantations, for the reason that they are more durable and lighter-looking. When of a proper construction, and rightly hung on wooden posts, they answer admirably, but we have invariably experienced that they are more liable to get out of order from accidental contact with carts coming into or going out of the field than wooden ones are. With careful work-people on a farm, however, iron gates are calculated to last much longer than wood ones; and to those who prefer them, we here give a sketch of one formed on a plan well adapted to stand the usual knocking about and wear that gates on fields are subjected to, and which we have had put in use for a number of years past on some places which we have had to do with. Fig. 56 is the sketch we refer to. Gates of this pattern can be had,

made of the best wrought-iron, with all the necessary mountings for fitting them on wooden posts, for prices varying from 30s. to 40s. each, according to the strength of the material. In using these iron gates, whether on fields or woods, they should be hung on wooden posts, and not on cast-iron pillars as is sometimes done. We recommend this point, because we have very often found that where cast-iron pillars have been used they get injured, and even broken over, by very slight causes, while wooden posts are not liable to this objection, but stand against any ordinary contact with carts, &c.

Fig. 56.



535. It is often found convenient to have small wickets upon certain parts about gentlemen's grounds, particularly upon the edges of plantations through which pleasure-walks are made; and as it is frequently inconvenient to have such wickets to open and shut in the same manner as common gateways, it is desirable they should be constructed so as to be what may very properly be termed *self-shutting*. Of this description of self-shutting wickets we know of none more simple and effective, both as a fence and a gate, than that shown in fig. 57, which is generally termed the angular wicket. The opening in the fence, from *a* to *a*, may be about 4 feet wide; the angular part of the wicket, *a c c*, may be about 3 feet wide between *e* and *e*, and may be made up with any convenient sort of wood, according to taste,—observing to have a post upon each of the extremities, and one at *e* upon each side, in order that the wicket *a d* may hit upon one as it folds to either side in the act of opening or shutting. The wicket *a d* may be made of light wood, and hung with a hinge upon a post at *a*. The particular properties of this sort of wicket are—first, that it is of a most simple and easy construction; second, it is easy for any person to have access through it, and that without the trouble of shutting or locking; and third, whatever description of cattle may be in the adjoining fields, they can have no access through, seeing that if they do attempt it, the wicket as they go in shuts upon the opposite side before them.

Fig. 57.

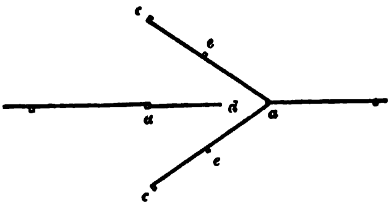
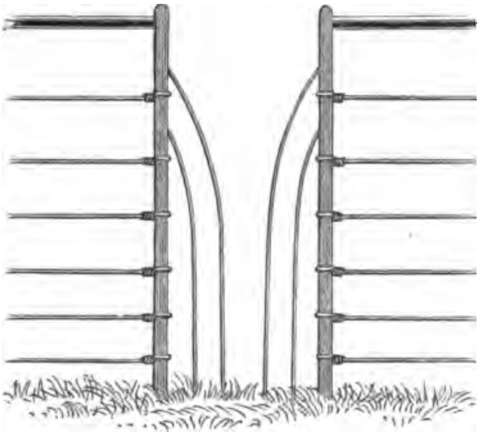


Fig. 58.



536. Where a pass is necessary in the line of a wire fence, what is called the "Birkwood" patent biped pass is admirably adapted for the purpose—see fig. 58. The peculiarities of this pass are evident at a glance, and these are, that it is always open, and at the same time always shut, requiring no hinges, and therefore not likely to get out of order. It is sold by Messrs A. & J. Main & Co., wire merchants, Glasgow, London, and Dublin, with whom the patentee has made arrangements for the use of the invention. It answers excellently as a pass for people on the side of a large gate, which for some reason requires to be kept generally shut.

CHAPTER V.

SECTION I.—PREPARING OF GROUND FOR THE GROWING OF YOUNG TREES.

537. Among arboriculturists one of the leading questions of the time is, Ought not ground to undergo some suitable course of preparation before it is planted with a crop of forest-trees, in order to promote a more rapid growth, and consequently a much quicker return than has hitherto been obtained from this description of produce? This is a very natural and proper question for every forester to ask, seeing that in all other classes of crops reared in the country so much attention is now paid to the preparation of the land for them, while in the rearing of trees comparatively little attention is generally given to the preparation of the land on which they are to be planted; and as the question is one which stands the first to be answered on entering the gates leading to forestry, and even, as it were, forms the foundation-stone of the subject, we shall devote a few paragraphs in reply to it.

538. Then, in the first place, what are the conditions of land which are found to promote the most rapid growth of trees, and consequently the quickest return from them as a crop? Our answer is, *Great depth; freedom from stagnant water; porousness to a great depth;* and consequently, *a large capacity for absorbing heat.* These are the conditions of land which have brought agriculture in this country to the state it is found in in the best-cultivated districts; they are the conditions of land on which the largest and most valuable crops of timber are found in the natural forests of America and other parts of the world; and they are the conditions we must secure to our ground in this country, wherever we wish to grow valuable crops of trees within the shortest possible time.

539. Drainage is the means whereby we are to secure these favourable conditions of our land for the growth of our tree crops. It is only by *perfect* and *skilful* drainage that they can be made good; at least in the mean time no other means of effecting this improved state of things on a large scale are known. Drainage is the pioneer

of all improvements in land—in fact, without it, on most lands, cultivation on the surface would be unprofitable.

540. Many are of opinion that the advantages of drainage consist chiefly in the removal of water. But water is not a disadvantage of itself in land; on the contrary, plants could not live without it, and its absence would be attended with the most fatal results to them. It is the excess of water that injures plants, and the excess of food has a similar effect upon many of them. Drainage not only removes the excess of water, but produces a great increase in the heat of the UNDERGROUND CLIMATE. Professor Schubler long ago came to the conclusion that the loss of heat caused by evaporation in undrained land amounted to from 11½° to 13½° Fahr. Mr Parkes has shown, in his 'Essay on the Philosophy of Drainage,' that in draining the Red Moss, near Bolton-le-Moors, the thermometer in the drained land rose, in June 1837, to 66° at 7 inches below the surface; while in the neighbouring water-logged land it would never rise above 47°. This points out a fact which every forester may prove for himself, and shows what an advantage is gained by perfect and skilful drainage in respect to increase of heat in the climate for the more rapid growth of trees.

541. The reason why drained land gains so much heat, and that wet land is always cold, consists in the well-known fact that heat cannot be transmitted downwards through water.

542. The effect of judicious drainage, then, is to increase the summer temperature of the land from 10° to 20° as compared with wet and undrained land; and the cause of this increase in heat is the increased capacity of the land for absorbing the sun's rays as they fall on it after the removal of the superfluous water which lay in it before the operation.

543. Another important effect of perfect and skilful drainage of land is that of adding to its available depth for the roots of trees securing a large increase in their supply of food. The deeper that drainage can be made thoroughly operative on land, the deeper will the conditions of its porousness be secured, and hence its greater capacity for absorbing heat, and for its becoming a large and deep storehouse for supplying the roots of trees with an increased supply of wholesome food.

544. When the soil is perfectly drained, the warm rain trickles through the pores in the earth, carrying down to the drain-level the high temperature it had gained on the surface, parts with it to the soil as it passes downwards, and thus produces the bottom-heat which is so well calculated to make trees grow rapidly.

545. Soils in the favourable condition stated in the foregoing paragraphs absorb a large amount of heat during the summer and

autumn months, and that to a depth corresponding to the operative depth of the drains. This store of heat, though gradually given off on the approach of winter, is maintained for a sufficient length of time to secure the maturing of the young wood of the trees before frost sets in to injure it; hence in all kinds of seasons it is found that trees make very much larger growths on land well prepared by drainage, and withal ripen them better, than trees of the same kinds and on the same quality of land naturally, but without drainage.

546. Then, in order to promote a more rapid growth, and consequently a much quicker return from our tree crops than has hitherto been obtained from them, we must prepare the land on which they are to be planted by a deeper and more thorough and effective system of drainage than we have hitherto put into operation; and for our recommendations as to how this should be gone about, we have to refer to the chapter on drainage in a subsequent part of this book.

547. To conclude this section, we have to state that whatever be the nature and character of land,—whether it may be clay, heavy loam, light loam, sand, or gravel—whether it may be situated on a high and exposed part of the country, or on a low-lying and sheltered district,—it requires no preparation for the growth of trees other than an efficiently conducted system of drainage, whereby its absorbing capacity for heat may be increased to the greatest available depth. This put properly into operation—if the land is not at an altitude too high for the healthy development of any of our known trees—a crop, and that a heavier and more profitable one than has hitherto been obtained, of some sort of tree will grow upon it, according to its position and texture. We find this as the result of more than forty years' experience in the raising of plantations upon all descriptions of land—from that only a few feet above the level of the sea to that about 2000 feet in elevation. In short, no one need entertain the thought of a failure in respect to growing a crop of healthy trees upon any description of land, whatever may have been its former condition, by a proper and efficient application of drainage, by a right selection of the plants in accordance with the soil and situation, by opening holes for the plants in order to improve the soil previous to their being planted in it, and by a judicious system of planting; all of which points will be fully referred to and described in their proper places.

SECTION II.—DOES LAND HAVING GROWN A CROP OF TIMBER REQUIRE ANY PARTICULAR COURSE OF PREPARATION PREVIOUS TO ITS BEING REPLANTED WITH YOUNG TREES?

548. Many hold the opinion that a crop of trees will not succeed satisfactorily on land that had been formerly under a crop of the same sort of trees, and on which they had become matured; and the reason invariably given for this is, that the former crop had exhausted the land of the proper food for a second of the same kind. In this statement, taken as it stands, there is certainly much of truth, but there is also in it much that is erroneous, and which in consequence leads to false conclusions. The statement is, generally speaking, true, in respect to the growth of any kinds of trees planted on lands not adapted to their healthy development, as those are on which we generally find them in a state of nature; while the statement is in error when applied to the growth of the same kinds planted on lands in all respects adapted to their healthy development: and it is from not considering the question in these points of view that false conclusions have been arrived at on the subject.

549. For example, on the low-lying and table-lands of the south generally, and apart from the hilly and mountainous districts of the country, it is seldom found, except under peculiar circumstances, that larch and pine succeed to any great weight of timber in a sound state when planted as a crop on land that had been before occupied by trees of the same sorts; while on the granite districts of the north there are large tracts that have produced a second, and even a third crop of the one or the other of these trees, each successive one seemingly as healthy as the one before it had been.

550. In the natural pine-forests of Strathspey and Braemar, crop has succeeded crop, for aught we know, for thousands of years, and still that growing in them at the present day seems as good and healthy and large as that we find lying in the mosses, and which is the remains of crops that had stood and grown on the same land many centuries ago. And notwithstanding all the successive crops of pine that have grown on these forests, even at the present day, whenever a portion is sufficiently cleared of old trees to admit of air and light penetrating into the soil, we find a race of young and healthy plants rise up thickly all over, thus indicating that successive crops of the same tree will grow each as healthy and as luxuriantly as another on the same piece of land, provided always that the kinds used are planted in the land naturally adapted to them. Therefore the conclusion to be drawn from this is, that in order to grow trees upon any piece of land, it is only necessary to do the work on the

principles that nature has pointed out to us—viz., in accordance with the geographical distribution of plants.

551. In the great natural forests of America successive crops of the finest of timber have been reared, and are still rearing, under the same natural law. There, where nature has had her own way without any interference from man, we find the crops of past ages lying rotting in all stages of decomposition, while matured and young trees of the same kinds form the crop now growing on soil made from them; and wherever a clearing has been made by the winds, we find young seedlings of the same kinds as the parent trees quickly rising up in their places, all growing seemingly as healthy as the older trees of the crop, and likely to attain equal dimensions of timber. But in every case we find there, as well as in this country, that each kind of tree has its own peculiar site and soil—the pines occupying the dry and gravelly ridges, the hard-wooded kinds the rich, loamy, and clayey lands, while the larch and arbor vitæ luxuriate in the cool-bottomed parts.

552. It is the neglect of applying to forestry this sort of knowledge that is the cause of failures in planting generally, whether the land may have been formerly under a crop of trees or not. Larch may be planted after larch, pine after pine, and hardwoods after hardwoods, in all cases where the land is naturally adapted to their healthy growth.

553. It is therefore to be inferred from the foregoing remarks that no particular course of preparation is necessary on land in order to insure the healthy growth of a crop of young trees on it after its having grown a crop of timber previously, provided always that the principles that nature has pointed out to us are attended to in dealing with it, as described in the foregoing part of this section, and that the recommendations for its thorough drainage are put into operation as suggested in the immediately foregoing section for the preparation of ground for the growing of young trees in all cases.

554. The character of land is in all cases much altered, and that for the better, after undergoing thorough drainage; and this more especially holds good in respect to such land as has borne a crop of old timber, and on which a large quantity of decayed vegetable matter rests. It is well known that the operation has the effect of cleansing the land of many ingredients hurtful to the growth of plants, and of making it wholesome and fit for species which before the operation it would not support in health at all. But, besides drainage, any piece of woodland cleared of a crop of matured timber requires to be attended to in regard to the following points before planting it with another crop: 1st, All the refuse of the old crop should be carefully cleared and burned, and no part of it left on the land; 2d, The bark

of the old stumps left in the ground should be also cleared in a very careful way, and none of it left, so as to prevent lodgment for beetles and the growth of young shoots from them; 3d, The land should be allowed to rest under the action of the drainage for a period of four years after these operations; and 4th, The young crop should be adapted to the land, as already explained.

555. A change of crop is often absolutely necessary on woodland in order to insure entire success in replanting it—as where a crop of oak has been grown on very light and therefore unsuitable land, a crop of larch and pine will succeed admirably; and where a crop of larch has been grown to maturity on land of a heavy description, hardwoods will succeed well.

SECTION III. — ALL LANDS NOT OF A DEEP, POROUS, AND DRY CHARACTER, MUST BE MADE SO BY DEEP DRAINAGE BEFORE THE PLANTING OF TREES IS UNDERTAKEN ON THEM.

556. Although the draining of lands that are absolutely wet is by most people now understood to be necessary before planting trees on them, still that all lands having a retentive subsoil should also be drained may to many seem an extravagant recommendation in regard to the cultivation of trees. It is, nevertheless, a fact that cannot be contradicted, that trees in all cases succeed very much better on lands that have been improved by drainage than they do on the same description of lands in an undrained state, although apparently dry on the surface. Let any one who may doubt the correctness of this examine for himself in the case of his own woods, or in the case of the woods under his charge, and he will at once be prepared to admit the fact as we have stated it—that on any district of land, although not absolutely wet, the trees have attained a more healthy development, and therefore a more valuable bulk at a given age, on the drained portions than on the undrained, all other circumstances being equal. That it should be so is only in accordance with the usual course of nature; for when an outlet is made in the form of a drain, the escape of superfluous water from the land along its sides takes place at once—the water percolates downwards to the level of the outlet; while at the same time the outlet arrests the ascent of water from beneath, and thus not only preserves the surface-soil from undue moisture, but also opens up the subsoil, freeing it from the presence of noxious substances lodging there, and which, in undrained land, so very frequently lie in it and impair the growth of such deep-rooted plants as our trees are.

557. Let the forester who thinks it unnecessary to drain land

that appears dry on the surface take the trouble to examine it in the subsoil. He probably finds the upper 10 or 12 inches pretty open and porous; but under this depth he finds the subsoil so retentive that he has considerable difficulty to dig into it even to the depth of other 8 or 10 inches; and farther down he finds that he must use a pick in order to make an opening of little more than 2 feet in depth in all. Now we would ask, How is it possible that the roots of young trees could with advantage penetrate this poor, stubborn subsoil in search of food, when it requires an iron pick to penetrate it? In consequence of this condition of subsoil, the roots of the trees, if there are any growing on it, are arrested in their descent, and are spread out on the surface only, struggling for an existence in the upper 10 or 12 inches of the soil. But, on the other hand, take a drained part of the same land, and it will be found, if it has been thoroughly drained and lain a considerable time under the action of the drains, porous and dry down to nearly the level of the bottoms of the drains, allowing the roots of the trees to go down in all directions to that depth; and, in consequence, the trees are found strong and healthy, and making great progress as compared with those on the undrained parts.

558. One has only to compare the miserable crop of timber that is generally taken from land of a retentive nature of subsoil with that grown on land of an opposite character, to be convinced of the great utility of drainage in opening up and deepening the land for the growth of trees. Take the crop of matured pine, for example, standing on land of a retentive nature in the subsoil, but still apparently dry enough on the surface. Taking the crop on a few acres, we should say that the trees will not average more than 15 cubic feet each; while on deep, open-bottomed land, the same kinds of trees, of the same age, will probably measure, on the average, 40 feet each. This at once points out the great difference there is in the value of a crop of trees grown on land of a retentive nature in the subsoil compared with that of a crop grown on deep open land. Generally speaking, the crop of any kind of tree grown on land of a deep, porous, dry character, is of three times the value of one grown on land that is retentive in the subsoil, although seemingly dry on the surface—and this points out the extent of the advantages gained by draining.

559. But great as are the advantages obtained for the growth of trees by the deepening of the soil by a well-conducted system of drainage, there is another that invariably follows, perhaps not less important in its results—namely, that of increasing the temperature of the soil; and although we have referred to this point in a former section, we consider it of such importance that it should be again

brought under notice to illustrate this branch of the subject. The increasing of the temperature of the soil is a fact not generally recognised among those who have to do with the cultivation of trees, and hence the great neglect there is of drainage at the present day, excepting, indeed, where the land is absolutely wet. Most foresters seem content to drain only those parts of their woodlands which are evidently wet, as if drainage was of no other use than to carry away superfluous water from water-logged spots, not keeping in view the equally great advantages gained besides in the capacity given to the soil for the absorbing of heat. In fact, besides the opening up of the land and rendering it a deep storehouse of food for trees, drainage also increases the temperature by several degrees, thus making a change on the climate of the land equal to removing it from a site 1000 feet in elevation down to one nearly at a level with the sea. These are immense advantages gained by drainage—so much so, that trees which will usually succeed only on low-lying situations may, by well-directed drainage, be made to prosper equally well on land at an elevation of fully 1000 feet higher than those.

560. Indeed there can be no doubt that many diseases and causes of unhealthiness in plantations proceed from deficient warmth about the roots of the trees; so that when parching winds come upon them, they are not provided with the means of resisting the cold—their vessels shrink, their fluids become vitiated, their blood, as it were, is corrupted, and disease must of course follow; therefore the penny-wise system of dealing with the planting of forest-trees, which has hitherto been so much an object, must be abandoned, and a more liberal and consistent one introduced and carried out.

561. Every agriculturist who is not behind the times knows well that unless he judiciously expend capital on the preparing of his land for the growing of the plants he cultivates, he certainly will not succeed in raising them of first-class quality, and in abundant crops; and the landed proprietor who wishes to secure first-class crops of trees on his woodlands must go to work on the same principle. This is, in respect to crops of trees, to deepen all lands of a retentive nature in the subsoil, although seemingly dry on the surface, as well as those that are evidently wet, before planting them, and that by a well-conducted system of drainage suitable to the particular character of the land, whereby the roots of the trees will easily get down, and so have a full supply of healthy food within their reach, and the warm rains of summer trickle through every pore, carrying with them heat and nourishment to every point of every root; and while filtering through, not only will they impart to the soil those substances which are useful to the roots as food, which it always contains in greater or less abundance, but they will wash out of the

whole depth of soil operated on by the drains such noxious substances as naturally collect and generally prove hurtful to the roots of trees in an uncleansed subsoil. The latter is one of those benefits which gradually follow the drainage of land, and one which, when once thoroughly effected, constitutes a most important permanent improvement in all lands so long as the drains are kept in a perfectly operative condition.

562. It is evident to every intelligent man who is sufficiently acquainted with the great benefits of drainage to crops on land, that the cause of a very large proportion of our existing plantations being so inferior as we find them is attributable to neglect of thorough drainage in the land they occupy. No doubt a large extent of drains has been opened on the wetter parts of the land under woods within the last thirty years, but these have, for the most part, been too shallow to be thoroughly operative on the land—hence they have been only of a partial benefit to the crops. We therefore repeat what has already been stated on the point, that to make our tree crops more remunerative than they have hitherto been found, we must thoroughly drain "*all lands not of a deep, porous, and dry character*"—or, in other words, *every description of lands having a retentive subsoil*—before we go to the expense of planting them, whether they may seem wet or dry on the surface; as it is not only the surface-soil that must be made open and wholesome for the roots of the trees, but the subsoil as well, and that to as great a depth as can be managed, seeing that the deeper the soil is made the more rapid will be the growth of the trees, and therefore the greater will be the bulk and value of the crop ultimately.

CHAPTER VI.

SECTION I.—DRAINING AS APPLICABLE TO ARBORICULTURE.

563. Although the application of drainage as a means of improving and renovating the soil for agricultural purposes is now pretty well understood and appreciated in this country, still this cannot be said with equal truthfulness in regard to its application for arboricultural purposes, as a comparison of the state of the land under farming with that under plantations affords evident proof. Notwithstanding this, the benefits resulting from thorough drainage are as certain in the one case as in the other, although a greater length of time is necessary to prove its beneficial effects on a crop of trees than on one of corn; and from this proprietors of woodlands have been slow to expend much money upon their drainage. In respect to drainage, it may be generally stated that the woodlands of this country are at the present day very much in the condition that agricultural lands were some forty years ago.

564. Drainage, as applicable to arboriculture, is necessarily a very different operation from that usually practised for farming purposes, inasmuch as the plants grown in the former case are of a strong and permanent character, and send their roots down into the earth deeper and deeper every year successively, till their maturity is attained; while the plants raised in the latter case are mere annuals, with soft and perishing roots, generally dying—with the exception of the grasses—within a few months after they are sown.

565. For the reasons just stated, drains made on agricultural fields are properly covered up and hidden, both in order to keep the material of which they are made from accident, and to secure all the breadth of land possible for farm cropping; while those made on woodlands are with equal propriety left open, as they would, generally speaking, be gradually rendered inoperative by the descent of the roots of the trees into them in search of moisture.

566. Drainage, where it has been properly applied to agricultural land, has been the means of improving the produce to an extent

which formerly could not be credited; and if it has thus increased the revenue of both the proprietor and the farmer, it is only reasonable to suppose that if it were comparatively as extensively and as judiciously applied to arboriculture, it could not fail to be the means of increasing the value of its produce in an equal degree. In proof of this we could point out large districts of wet land which had been planted with trees seventy years—before the advantages of drainage were understood—but which failed to succeed, now under a new crop of trees, in a fair and promising condition, simply from having been drained.

567. Drainage, then, where properly applied to the rearing of trees, is as advantageous to the increase of their produce as it is to that of farm cropping. Therefore, as it is the very first step in agricultural improvement, it is equally so in arboricultural, and indeed, in all the departments of rural economy.

568. In agricultural improvements drainage is being put into operation on nearly all descriptions of lands, as experience has taught farmers that they can rear much more valuable crops from land which has had its subsoil opened up and cleansed by thorough drainage than they could ever do from the same land while it lay in an undrained state; and the same result follows in respect to crops of trees on drained land as compared with those on undrained, whether it may have been wet or seemingly dry before the operation.

569. The general specifications for drainage suitable to arboriculture may be set down as under—viz.:

On light, open-bottomed lands, the drains should be made in the form of open cuts—to be particularly described in next section—3 feet deep, and from 55 to 60 feet apart;

On lands of a medium character in respect to their openness or retentiveness in the subsoil, the drains should be made 3 feet 6 inches deep, and from 40 to 45 feet apart; while

On lands of a stiff and retentive character, the drains should be made 4 feet deep, and about 35 feet apart.

SECTION II.—DRAINING OF LAND FOR THE GROWTH OF TREES PRACTICALLY DESCRIBED.

570. The land intended for a new plantation being all well fenced, the next important step to be taken, in order to fit it for the reception of young trees, is draining it, which draining must be executed over all the wet and retentive portions of the land embraced, whether the retentive parts may look wet or dry on the surface, and that in such a manner as to free the whole of it from all superfluous mois-

ture, and to keep it in a clean, open, healthy state, to a depth of from 3 to 4 feet. We may here remark, that all drains made in plantations among trees, whether these may be old or young, ought to be left open. To cover drains where the roots of trees have access to them is the most effectual way of ultimately rendering them useless. They might, indeed, answer the purpose for a few years; but as soon as the roots of the trees began to spread themselves firmly into the soil, they would collect about the drains more than any other part, and the consequence would be, that in a very short time covered drains would be entirely choked up with the roots, and rendered useless.

571. The distance apart at which drains should be put on the ground depends entirely upon the nature of the soil to be operated on —that is, if the soil be a stiff clay, or any other of a very retentive character, the drains may require to be laid on as close as 35 feet one from another; and if, on the contrary, the soil be of an open sand or gravel, through which the water can pass freely, 60 feet distant may not be too far separate. In all cases where we drain for the planting of forest-trees, of whatever nature the soil may be, we never now put on drains closer than 35 feet, nor wider than 60; for beyond that distance between drains land cannot be said to be drained efficiently.

572. The depth and general size of the drains must in a great measure be regulated by the nature of the soil. In a heavy clay soil we now find that open drains, such as are generally used on woodlands, should be at least 48 inches deep—upon a light friable soil, 36 inches may be quite deep enough; and according as the soil may be inclined to be light or heavy, any intermediate depth between the two extremes above specified may be fixed upon, always observing that the more the soil is inclined to clay or moss, the deeper the drains should be made. Within the last twenty years we have had a very extensive experience in the drainage of land for trees in all parts of the country, and from this we have found it absolutely necessary to depart from the depths of drains formerly considered sufficient to dry ground, as we found that drains made from 24 to 36 inches, as at one time recommended, were not deep enough to dry and open up the subsoil of land sufficiently for the healthy growth of trees. We now, therefore, lay down 36 inches as the least depth we would recommend for draining under any circumstances, and 48 inches as the greatest. In all cases of draining on moss land, a sufficient allowance should be made for subsidence, as such soils generally shrink from a fourth to a third of their bulk after drainage, according to the quantity of organic matter in them.

573. The breadth of all such drains at the surface of the ground

must of course vary according to the depth required, and the natural texture of the land itself. The rule which we have now laid down for our own practice as regards this is, to make all open forest-drains, on land of a light texture, one-third wider at top than the depth intended—that is, if the depth of a drain be fixed upon as 3 feet, the breadth of the opening at top will require to be 4 feet, this breadth at the top being necessary to admit of the sides of the drains on light land having sufficient slope to support themselves without crumbling down. On the other hand, in making open forest-drains on land of a stiff and retentive nature, whose sides are not apt to crumble down, and therefore do not require so much slope as drains on light land, our rule is to make the surface-opening only three-fourths of the depth—that is, if the depth of a drain be fixed at 4 feet, the breadth of the opening at top will require to be 3 feet only; and these proportions we have found to answer very well. But in applying them, considerable judgment is necessary to distinguish as to the retentive or non-retentive nature of the land; for if it be of an open and somewhat free character, and the sides of the drains are made with too little slope, much mischief may follow by their crumbling down and partly obstructing the action of the drains. Therefore the nature of the land requires to be carefully considered in respect to dealing with this matter. The breadth of all forest-drains at bottom ought to be about 8 inches, or sufficient to allow a spade of this breadth to pass along for the purpose of cleaning.

574. A particular point to attend to in the draining of moor or waste land, for the planting of young forest-trees, is the manner of laying on the drains upon the ground: they must be laid on in that position which is found to be the best adapted for drawing off and intercepting the superfluous water in its natural descent. We have seen many plantations of considerable extent drained in a very inefficient manner, the drains not having been properly laid down upon the ground. To those who may be unacquainted with the art of making open drains upon moor or waste land, the following hints may be useful: It is a very simple process to drain any piece of land having a moderate natural descent to one side. In such a case nothing is necessary but to make the drains in that direction which is indicated by the fall of the ground; but where the ground may be what is termed a *dead level*—that is, having no perceptible fall to either side—the case is altogether different, and it requires both experience and consideration to drain such a piece of ground properly. Again, where the surface to be drained is a steep slope with many inequalities, much caution and consideration are necessary in order to lay on the drains upon the ground in that position which is most likely to be effective in intercepting the water as it falls from the

various high parts into the hollows; and in order to make all this as plain as possible, we shall illustrate the manner of going to work by reference to a few figures.

575. The operator, in making open drains upon moorland, must be provided with common tools as generally used for that purpose—namely, the line upon *a reel*, with iron pin attached to the other end, for marking off the drains; a turf-spade (see fig. 16), for the purpose of cutting up the surface or turf; a common pick (see fig. 59), for loosening the subsoil and taking out stones where they occur; and the common spade, for throwing out the earth and clearing up the bottom of the drains. In operating among the roots of old trees it is also found necessary to have in use the implement called the mattock, or pick-axe, which is merely a sort of pick having its two ends made in the shape of an axe—the one end with its axe made at right angles with the handle, and the other on a line with it (see fig. 60). With this implement, with its axes made to cut different ways, the operator can with great convenience cut roots lying in any position in the ground. The most necessary implement for the superintendent of draining operations is the spirit-level (see fig. 61), which no drainer ought to be without. There are various descriptions of levelling instruments sold for the purpose, at prices varying from 15s. to 45s.; but the one we use ourselves, in the case of taking levels for drains, is shown in the figure, and costs 15s., being of a simple construction, and easy to carry about in the pocket. In using it we put the instrument, with appendages, into a hole bored by a gimlet in the top of our walking-staff, as shown in the figure. When in use, the spirit-level is placed in a frame of brass, a part of which operates by pressure against the bottom of the instrument as a spring to adjust it to the level position *d*, by turning the large-headed brass screw *c*.

Fig. 59.

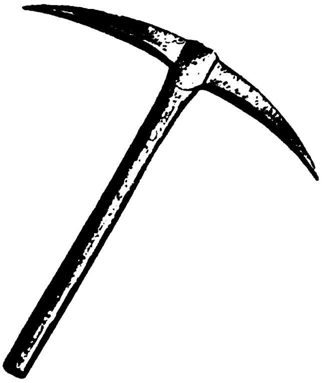


Fig. 60.

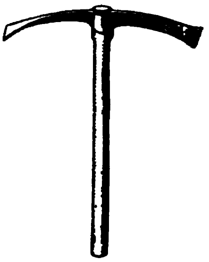
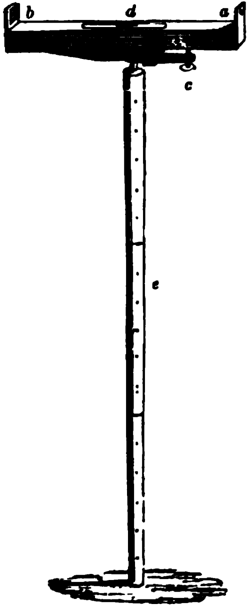


Fig. 61.



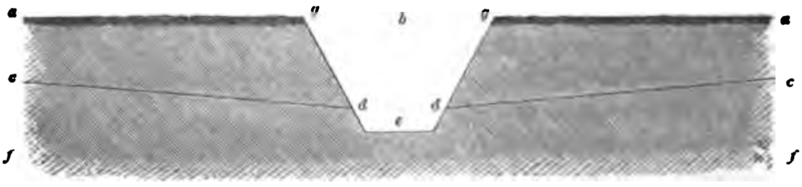
A perpendicular stud is fixed to the under part of the framing, and placed firmly into the gimlet-hole in the top of the staff *e*, which is pushed into the ground at the spot from whence the level is desired to be taken. There are two eyesights, *a* and *b*—*a* being merely a small hole for the eye to be placed against, and *b* a square opening, with a hair-wire crossing it in the middle.

576. Being furnished with the implements above mentioned, and having a spirit level of the description referred to, if it is required to drain a flat bog for the purpose of planting trees in it, the drainer will proceed as follows: Look for the lowest part of the ground to be drained, and if this cannot be decidedly ascertained by the eye, set up the spirit level about the centre of the flat ground, and take sights from it all round in order to find out this point. In using the instrument, it may be unnecessary for us to notice that the height of the eyesight *a* from the ground must be deducted from the point observed —that is, if the object-pole used be marked in feet and inches, and the hair-wire, in taking a sight, hit the same at 6½ feet, then, if your eyesight be 3 feet from the ground, the difference of level between the two stations will be exactly 3½ feet; that is to say, there would be 3½ feet of descent from the spirit-level station to that of the station where the object was placed. On the other hand, if in looking through the eyesight the hair-wire hit the object-pole at 12 inches from the ground, this 12 inches must be deducted from the height of the eyesight: and supposing that to be 3 feet, then the ground at the station-pole must be 2 feet higher than that at the spirit-level. Having ascertained, by the use of the spirit-level, the lowest part of the ground to be drained, and being aware how deep a main drain can be got made there in order to carry off the water from it, cut a main drain along the lowest part of the ground all through, and make it empty itself at the lowest point possible. This main drain must be made of a size correspondent to the quantity of water it is likely to be required to contain, which will depend upon the extent of ground to be drained: in the present case the main drain must be deeper than ordinary, in order to give fall to the smaller ones into it; but in a moderate case we may say 5 feet 6 inches deep and 6 feet wide at top. Now let fig. 62 represent this main drain upon a flat piece of ground: from a little explanation on it we will be able to make ourselves properly understood in reference to the smaller drains which are to be led into it.

577. Having made the main drain of the form shown in the figure, lay off your smaller or common drains at proper distances—say 40 feet from each other—and at nearly right angles to the main drain; and in making these, say that you wish to have them 42 inches deep, make them that depth at the top, or the end furthest from the main

drain, as at *c c*, and proportionally deeper as you approach it; and when you finish the small drains into the main one, you can have—

Fig. 62.



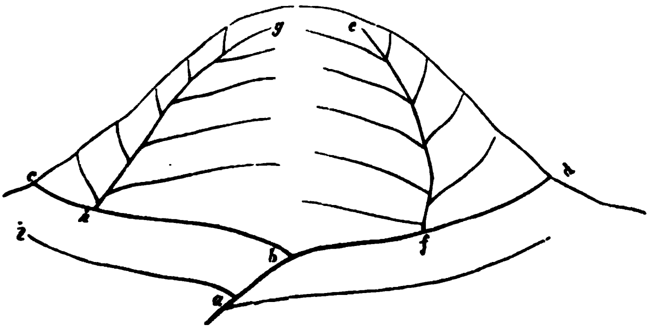
we are supposing the land to be a dead flat—1½ foot of descent between the two ends of your drains, which is quite enough for a drain of any ordinary length in a plantation, where they are left open, and of course can be scoured in order to keep a clear run. The run of these small drains is represented by the two lines *c d* on each side of the main drain *b* in the figure. From the surface at *a* to the bottom of the upper end of the drains at *c*, is 42 inches; and from the surface upon the side of the main drain at *g*, to the bottom of the lower end of the small drains at *d*, is 69 inches, giving 18 inches of a fall upon the small drains from *c* to *d*. It will be observed that the lower ends of the small drains at *d* are kept a few inches above the bottom of the main drain at *e*: this precaution should in all cases be used where there is not much descent for the water. Were the smaller drains made to terminate in the very bottom of the main one, the accumulation of mud from the different small ones would soon be so great as to check the progress of water at the ends, and cause the drain to become stagnated; but by keeping the bottom-level of the main drain a few inches under the bottoms of the small ones, although mud should accumulate in the former to a considerable extent, the others are not affected by it; and if the main one be cleaned once a-year, all is kept right in regard to the small ones.

578. It is a point of practical wisdom in draining not to have too many small drains running into a main one, unless, indeed, it be of very great dimensions; but if it should be found necessary to continue all small drains into one main for a great length—which will depend upon the nature of the ground—the latter should be made larger as it increases in length, with the view of containing the increase of water from the small drains upon its sides. When water increases to a great quantity in a main drain made upon soft soil, it is very apt to be injured, and to have its sides broken down or wrought in upon: in order to avoid this, it is a better plan not to allow the small drains to run above 150 yards without falling into a large one, which, if possible, should be made to have an outlet for

itself, without the bounds of the plantation, or into a stream, if the ground contain one—for a natural stream or burn makes at all times the best outlet for water from main drains; and, if possible, this should always be done.

579. In putting open drains upon land having a steep declivity, they should be run nearly at right angles with the descent of the ground; but, at the same time, care must be taken to make every drain with a slight fall downwards—for if they have not at least one foot in a hundred of descent, they will be apt to become choked up with mud and vegetable matter, which is sure to accumulate if not carried away by a brisk run of the water in the drains. We have already said that where the ground has a slight natural fall—say of about two or three in the hundred—the drains may very properly be made to run in the direction of the same; but beyond this the fall would be too much, and would certainly prove injurious to drains. Caution, therefore, is necessary upon this point, in case of overdoing the thing; for if the drains were to be made with the natural fall of the ground—that being, say, four to six in the hundred—the effect of such a rapid descent of the water during a flood would ruin the drains; and if the soil were of a sandy or gravelly nature, the undermining of their sides could not but take place, and the whole work would prove comparatively a ruin. It should in all cases be observed, where the soil is of a light, sandy, or gravelly nature, to give no more descent to the drains than will carry the water briskly along and prevent stagnation; and where the soil is stiff, a quicker descent may be given without doing damage so speedily as in light soil. In order to make the method of draining upon steep slopes as easily understood as possible, we shall illustrate the same by reference to fig. 63, which is a representation of our method of draining a hill-side with open drains for a young plantation, and which we consider the best method possible for intercepting water in such situations; and as we find that

Fig. 63.



Mr Stephens, in his 'Manual of Practical Draining,' has a similar illustration, we shall here give the same, with his explanation. In speaking of making open sheep-drains upon hill-pasture land—which is equally applicable to plantation-ground in like circumstances—Mr Stephens says: "Open surface-drains in permanent pasture (or plantation-ground) exhibit the form represented in fig. 63, where the leaders (or sub-main drains) *e f* and *g h* are cut with the greater slope down the hill the steeper the face of the acclivity is, and the feeders (or small drains) are cut across the face, nearly in parallel lines, into their respective leaders. In this way the water is entirely intercepted in its passage down the hill. Where one drain enters another, the line of junction should never be at right angles, but always at an acute angle with the line of the flow of water, as at *b*. And where small drains enter a large, they should not only enter with such an inclination, but where they come from opposite sides, as in the case above, they should enter at alternate points, as shown by the three drains above *f*, and not as represented by the three pairs of drains above these towards *e*." The large drain *c b d* may either form a part of the lower fence of the plantation, or run along the bottom of the hill-ground; and the main drain, from *b* to *a*, be made to run out in the direction of the outlet; and other small drains, as at *a i*, be made into it upon the level ground, if required.

580. All the drains should be made with a regular and equal slope from top to bottom on both sides, and the bottom of each left with a smooth and regular run from the higher end to the lower, where it enters the main drain, into which it should be turned so as to throw its water on the line with that running in the main.

581. As each drain is opened and completed, the earth and turf taken out of it should be broken and spread in a regular way over the ground between it and the next drain, in order to improve and deepen the land all over; and on no account should the stuff be left in ridges along the margins of the drains, as is too frequently done, causing it ere long to tumble down into the cuts, where it obstructs the free passage of the water in them, and so injures their desired efficiency.

582. All sub-main drains should be made in a position between the main drains and the smaller ones; and as they are intended to collect the water from the smaller drains and convey it to the main ones, they should be of a convenient size between the two. All open drains in a wood ought to be examined and cleared out once in two years; for if they are not attended to in this respect, they are apt to choke by vegetable matter lodging in them if the ground be level, or by gravel if it be steep and the land of a light character.

SECTION III.—UTILITY OF ROADS IN FORESTS AND PLANTATIONS.

583. There is nothing that facilitates forest operations so much as judiciously laid out roads; they not only promote a superior mode of all the usual works that are necessary in tree-culture, but they invariably add a large percentage to the value of the produce as compared with that from plantations in which no well-arranged system of roads exists.

584. We think that we speak within bounds when we assert that the produce of any plantation—say of some hundreds of acres in extent, and in which there are no roads well laid out for the convenient removal of wood—is at least 20 per cent less in value than that of a plantation of the same extent, and under equally advantageous circumstances otherwise, but in which there are roads well and conveniently laid off. This is a fact which must appear evident even to the inexperienced in such matters, as the removal of produce from a large plantation in which there are no proper and convenient roads is such a drawback upon its value as to prevent many from engaging in it at all, and consequently compelling the proprietor to take for wood lying in such a plantation whatever price may be offered for it, and such price as he would not accept under other circumstances.

585. We have so frequently seen the very great loss sustained by proprietors from the want of roads in their plantations, that we have to condemn in the strongest terms the extremely narrow policy of planting any enclosure of considerable extent without laying out, and that in a proper and judicious way, roads in it. The necessity of roads in a plantation is not, of course, felt at first when it is planted, and from this the making of them at such a stage is often put off and altogether neglected on the score of expense; but this is a great mistake in forest management, and invariably proves a source of unsatisfactoriness in the long-run.

586. When we took the management of Lord Seafield's woodlands, we found few or no roads in any of his extensive forests, and in consequence of this no timber merchant of any standing would come into the country to make a purchase. Our very first work, therefore, was to have roads made so as to completely open up the forests from all points; and since this important work has been accomplished, there has been no difficulty in getting purchasers of the most respectable class to come into the country and settle in it, so as to do a large business.

587. The utility and advantages, therefore, of roads in forests and plantations are immense, and should on no account be lost sight of by any proprietor who wishes to make the most of the resources of

his estate; as, where this is neglected—and we know it often is so—at least 25 per cent of the value of the produce is lost.

SECTION IV.—LAYING OFF AND MAKING OF ROADS IN NEW PLANTATIONS.

588. We have already hinted that, in all plantations of any considerable extent, it is absolutely necessary to have vacant tracts left through them unplanted, in the form of roads. In laying these off in a new plantation, care should be taken to see that no part of the wood is above 150, or at most 200, yards distant from some one of such roads. The necessity of this precaution will appear evident when it is taken into consideration that the trees, when grown to any considerable size, will have all to be carried from the interior to such roads, in order to have them taken away in carts; and when the trees become large, and require to be carried a considerable distance, much valuable labour must be wasted before they can be laid down cart-free by the men.

589. The roads in a plantation need not be made more than 18 feet wide. In all cases, however, they ought to be so broad as to allow two carts to pass one another with freedom when laden with wood.

When the roads are marked off, which of course should be done previous to the ground being planted, they ought to be divided from the rest of the ground by a drain 24 inches deep, running along each side of them throughout their whole extent. We recommend drains of this depth for the sides of roads, because when deeper they are often found dangerous to horses when getting into them with laden carts; and in order to prevent any risk of this kind, the sides next the roads should be formed with a very easy slope—say of about 35 degrees, thus making the inner sides of the drains form, as it were, the outsides of the roads. These are meant not only to keep the roads in a dry, firm state, but to give them an appearance distinct from the rest of the plantation; and being thus sloped into the drain on each side, they are not apt to be damaged by a cart or any other wheeled carriage passing along them; and they therefore form a fine ornamental green ride for the proprietor and his friends at all times, as well as answer the purposes of accommodation in wood operations. But in order that they may the better answer the ends in view, all sudden heights and hollows should be made easy by taking from the one and adding to the other; and where any very soft parts may come into the line, these should be made dry by a stone-built conduit passing across and under the road, so as to connect the drains on each side of it. Where they pass along the sides of a sloping hill, they should be levelled by cutting into the slope on the upper half, and by adding the material so removed to the lower. And of course all large stones should be removed from them, and the line made smooth.

590. If there be any particularly romantic-looking spot within the bounds of the plantation, the road should be made to take a turn in that direction; or if there be any particular height from which a distinct view of the surrounding country may be had, make a road to pass by it, with a narrow footpath leading up to it. In short, in making roads through a plantation, as well as in making walks through pleasure-grounds, good taste and ornament should be kept in view; and it is as easy to do any piece of work well as otherwise.

591. In plantations where good taste is kept particularly in view, it is very requisite to have holly-trees planted along the sides of the roads, as also privets, rhododendrons, Portugal laurels, laburnums, and bays, all of which thrive well although a little shaded by trees; and, in the winter season particularly, the evergreens give a fine effect when contrasted with the leafless hardwood trees. Indeed those ornamental points in forest scenery are by far too little attended to. Our woods might be made even more interesting than the best-kept gardens, in the winter season, were this kept in view—for what is prettier than a holly, with its clustering red berries, in the winter months, when the birds delight to congregate and feed upon them? And even in the month of June what is more beautiful than the rich clustering yellow flowers of the laburnum contrasting with the rhododendron, with its dark purple flowers? Such objects, when found in a forest footpath, give rise to reflections unknown upon beholding the same plants in a flower-garden.

SECTION V.—MAKING OF CLOSE OR SHUT DRAINS IN LAND OCCUPIED BY FOREST-TREES.

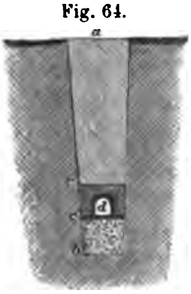
592. It often occurs about the home-grounds of landed proprietors' seats that open drains are an eyesore, although they may be actually necessary for the welfare of the trees which may be growing upon the ground in such situations; and it is in cases of this nature that proprietors are anxious to be made aware of the best method for preserving shut drains in such situations.

593. It is a well-ascertained fact that the roots of all trees incline more to spread about the sides of drains than any other part of the soil they may grow in, whether those may be shut or open drains; and of this we have had ample proof in the case of covered drains in fields along the margin of woods. No reasonable depth of drains will

suffice to keep the roots of trees from getting to them, for we have seen them choked at a depth of more than 7 feet: indeed this must be the case, as the soil in the immediate vicinity of drains is in a more healthy and attractive state than any other part of the soil to which the roots have access; and therefore they will congregate in those parts, and this is the cause of drains being injured by the roots of trees. Seeing that the roots of hardwood trees incline much to draw nourishment from drains, whether these may be open or covered, and being of opinion that keeping them from having access to such is injurious to their health, it is bad management, in the growing of trees, to keep the roots from having that nourishment which nature has provided for them in the soil: therefore a plan must be adopted which will not hinder the roots of trees from having access to the drains, but, on the contrary, one by which the process may be encouraged, seeing that trees in such a condition are more healthy than in any other state.

594. The following is a plan which we recommend to those who may have occasion to require shut drains among trees, which secures the safety of the drain, and allows the roots to have access to the water in it at the same time. It is the only rational method of proceeding, and will be understood by reference to fig. 64. The depth of this drain, from *a* to *b*, may be 48 inches, 9 inches wide at bottom, and 12 at top. In filling it, put in about 10 inches of broken stones or large gravel into the bottom, as from *b* to *c*, above which lay a sole of slates, as at *c*, for the drain-tiles *d* to rest upon. Between each sole leave a vacancy of an inch, in order to allow the water to rise up into the tiles from the gravel. The tiles being laid, surround them with a puddle of good clay, 3 inches thick on each side, and the same on the top *e*, and afterwards fill up the drain with the soil in the usual way.

Fig. 64.



This plan of making drains in ground occupied by trees, with the view of securing them from being easily injured by their roots, we have ourselves put into practice on several places, and some which have been twenty years made are yet quite as good as when first put in.

595. The principle of this kind of drain is, that the roots of all trees in the vicinity of drains, when they come in contact with them, travel along the sides of the drains, following the descent of the water to the bottom. Now, when there is a quantity of broken stones put into the bottom of a drain, the water will gather there from each side of the drain and filter along through it, consequently the roots of the trees will lodge there also; and as the space occupied by the stones

would not in all cases be able to contain the quantity of water that might lodge in the drain, a provision is made for any extraordinary flow, by having the tile placed above upon soles set a little apart, in order to allow the water the more readily to ascend into the tile, and find egress thus when it might attain this height. In general, however, the water would lodge at the bottom of the stones, and seldom rise to the top; consequently the roots of the trees would not incline to rise upwards into the tiles, seeing there was no food for them there, nor any moisture to attract them. By placing a band of clay over the tiles, the roots of trees are prevented from going downwards into them; and before they can enter the drain, they must run to the bottom, where they are retained among the moisture. Supposing that the stones were to become so full of the roots of the trees that the water could not pass through it, it could have a passage in the tiles which have been provided for this purpose; and as the water would still lie to a considerable extent among the stones, the roots would be detained there, and would not increase upwards for a great length of time.

CHAPTER VII.

SECTION I.—TREES CONSIDERED AS A PROFITABLE CROP, AND AS ORNAMENTAL OBJECTS OF LANDED PROPERTY.

596. That trees are a highly profitable crop on landed property has already been shown in a former section: we need not, therefore, recapitulate what has been stated on this subject. Still, under this head, we should wish to state a few facts as introductory to the sections which are to follow, and which relate to the character and habits of the trees we cultivate.

597. In all civilised countries the cultivation of trees forms a most important part of their economy, both from their timber and from the food they produce. From the timber of trees our houses are constructed; our implements are manufactured from it, as well as our furniture; while as a nation we depend greatly upon it for the support of our mines and railways. Besides these uses, in all countries trees are found to be improvers of the climate, inasmuch as they produce shelter from winds in a high-lying, cold, and exposed position, and shade from the burning heat of the sun in those of a hot climate. Not to speak of the fruits we have in this country from the produce of trees, as to us they are more a luxury than a necessary article of food, we may only refer to the fruit of the palms and of many other trees of hot climates, which are really as necessary to the inhabitants as the cereal crops are to us. Trees, then, form a necessary and a profitable crop in all countries at all advanced in civilisation, either in the form of timber or in respect to the fruits they produce.

598. But trees are not only profitable as a crop—they are also ornamental in the highest degree; for what objects in nature are so grand and so effective as old trees, with their massive stems and spreading limbs, covered with foliage of different shapes and shades? for hill-sides would be comparatively uninviting but for the plantations of trees of various shades we plant upon them; and what would be the effect of the waterfall or the river without trees in their neigh-

bourhood? A country without trees is as repulsive to the eye of taste as a picture of a landscape would be without one shown upon it. In short, we would ask, What adds beauty and natural effect to a fine mansion-house? What constitutes the charm and pleasure of country scenery in general? What gives rise to the ecstasy felt on viewing a cascade, or a lake with its islands? What is it that renders the home-parks of our landed proprietors so cheerful, so enlivening, so rich in beauty, and so much praised by the most cultivated minds? We confess that we are enthusiastic in the matter of trees, and that we not only admire them on account of their usefulness and beauty, but we have a feeling approaching to respect for them, more especially when we look upon gigantic specimens of them that have stood over four and five hundreds of years, and have witnessed many generations of feeble men pass away.

SECTION II.—WHAT PARTICULAR KINDS OF THE TREES WE CULTIVATE MAY BE CONSIDERED NATIVES OF THE BRITISH ISLANDS.

599. From the similarity of the climatic influences, and their general affinity to each other, we find that the ligneous trees which are indigenous to Great Britain and Ireland are also spontaneous growths in the more midland countries of the continent of Europe, such as in France, Germany, and Belgium. This is easily accounted for when we consider the many and various ways in which the seeds of trees are carried from one country to another, and the probability of the British Isles at one time having formed part of the continent to which they are now islands. Much controversy has always existed among our botanists as to the kinds of trees which are aboriginal to our islands of those which we find growing in our woods. This, however, is excusable when we consider the probable fact of many introductions by our first invaders many centuries ago, and which have now become acclimatised to these islands, and consequently are by some considered indigenous to the country. We are not surprised, however, to find that the real native ligneous trees of the country are but few compared with those of other countries. This follows from the small extent of land embraced, and the unsuitableness of the climate of a large part of the country to grow any but the more hardy species of the trees of the world.

600. The following list may be considered as embracing the principal timber-trees recognised by botanists as being of spontaneous growth in the British Islands, exclusive of their varieties, and including some kinds about which doubts are entertained by many as to their being native or not:—

Small-leaved lime-tree, *Tilia parvifolia.*
Broad-leaved lime-tree, *T. platyphylla.*
Common maple, *Acer campestre.*
Sycamore, *A. pseudo-Platanus.*
Common holly, *Ilex aquifolium.*
Hawthorn, *Cratægus oxyacantha.*
Common cherry, *Prunus cerasus.*
Mountain-ash, *Pyrus aucuparia.*
Common English elm, *Ulmus campestris.*
Wych elm, *U. montana.*
Sessile-fruited oak, *Quercus sessiliflora.*
Common oak, *Q. pedunculata.*
Common beech, *Fagus sylvatica.*
Common hornbeam, *Carpinus Betulus.*
Common birch, *Betula alba.*
Dwarf birch, *B. nana.*
Black poplar, *Populus nigra.*
White poplar, *P. alba.*
Aspen poplar, *P. tremula.*
Grey poplar, *P. canescens.*
Scots pine, *Pinus sylvestris.*
Common yew, *Taxus baccata.*
Common ash, *Fraxinus excelsior.*
Common alder, *Alnus glutinosa.*
Willows many, chief timber kinds—
  White willow, *Salix alba.*
  Bedford willow, *S. Russelliana.*
  Cracking willow, *S. fragilis.*

601. From the above list we see that of the many kinds of trees at present cultivated in the British woods and plantations, only a small proportion of them are real spontaneous growths of the country, and that the greater number have been introduced from time to time. This becomes more apparent when we consider that there are believed to be, at the present time, considerably upwards of 300 different kinds of trees growing in our woods which attain a timber-like size. Even some of the kinds named in the foregoing paragraph as being natives, are not recognised by some as belonging to our islands originally; but we prefer to take advantage of the doubt, and put them down in our list as trees of native origin. Besides, so little is known about the earlier introduction of exotic trees into these islands, that we can only assume on the subject of whether the *doubtful trees* are indigenous or not; but we think it may safely be said that all those trees which propagate themselves freely from seed without our agency, and which are known to have existed in our country beyond the earliest records, are indigenous to it.

CHAPTER VIII.

SECTION I.—THE HARD-WOODED KINDS OF TREES USUALLY PLANTED IN GREAT BRITAIN AND IRELAND.

602. The hard-wooded kinds of trees usually planted and cultivated for timber and ornament in our woods and plantations are chiefly as follow:—

Oak, *Quercus.*
Ash, *Fraxinus.*
Elm, *Ulmus.*
Beech, *Fagus.*
Maple, *Acer.*
Plane-tree, *Platanus.*
Poplar, *Populus.*
Willow, *Salix.*
Birch, *Betula.*
Alder, *Alnus.*
Sweet-chestnut, *Castanea.*
Horse-chestnut, *Æsculus.*
Lime-tree, *Tilia.*
Walnut, *Juglans.*
Tulip-tree, *Liriodendron.*
Hornbeam, *Carpinus.*
Cherry, *Prunus.*
Common hawthorn, *Cratægus.*
Holly, *Ilex.*
Mountain-ash, *Pyrus.*
Laburnum, *Cytisus.*
False acacia, *Robinia pseudacacia.*

This list contains all the *genera* of hard-wooded trees that are usually in cultivation in our plantations; and having given it, we purpose next to devote the following sections of this chapter to a full description of them. In attending to this, we shall devote a separate section to each genus, in which we shall describe the distinctive character, habits, and peculiarities of all the species we cultivate of it, referring minutely to the mode of cultivating them respectively to the best advantage, and to the economic uses of their timber. We begin with the first tree named in the list.

SECTION II.—THE OAK (QUERCUS)—LINNÆAN SYSTEM, MONŒCIA POLYANDRIA.

603. *Character of genus.*—Barren flower, in a lax catkin. Perianth single, somewhat 5-cleft. Stamens 5 to 10. Fertile flower. Involucre cup-shaped, scaly; perianth single, incorporated with the

germen, 6-lobed; germen 3-celled, 2 of them abortive; style 1; stigmas 3. Nut (acorn) 1-celled, 1-seeded, surrounded at the base by the enlarged cup-shaped involucre.—Loudon, 'Encyclopædia.'

604. There are upwards of sixty distinct species of the oak, chiefly natives of Europe and America. We shall only, however, refer to six of them—viz., to the two British oaks, *Quercus pedunculata* and *Q. sessiliflora*, as they are preferable to all other sorts for the quality of their timber; to the *Q. cerris*, or Turkey oak; to the *Q. Ilex*, or evergreen oak of the south of Europe; and to the two American sorts, *Q. coccinea*, or scarlet oak, and *Q. alba*, or white oak,—as these are hardy, and calculated to produce a highly ornamental effect in our plantations. We shall begin with the first named.

QUERCUS PEDUNCULATA, or the *common* peduncled *British* Oak.

605. *Specific character.*—Leaves oblong, subsessile, smooth, sinuated; lobes round. Fruit oblong, stalked.

606. *Geography.*—The *Q. pedunculata* is a native of nearly all parts of Europe, from Sweden on the north to the Mediterranean on the south, and is said to be found in the north of Africa, and on the west of Asia as well. It is the prevailing sort in all our British oak-woods, and in the forests of France as well, but is said not to be so common in Germany as the *Q. sessiliflora.*

607. *Description of tree.*—The *Q. pedunculata*, generally speaking, forms a massive-stemmed, large, and spreading-topped tree, naturally disposed to throw out large limbs, and to become what may properly be termed a flat-topped tree. The appearance of the tree is, however, very much influenced by the soil and situation it grows on. When growing on a high exposed site and poor soil, it becomes of a stunted, low-stemmed, flat-topped character; while on a low-lying situation, with a deep strong soil, it grows of an upright habit; and this again is modified by various circumstances, such as the trees being close together or standing far apart. In the former case they become comparatively branchless, tall, and drawn up; while in the latter they attain that full development both of stems and branches which renders the oak so much admired as an ornamental tree in landscape scenery. This sort is easily distinguished from the *Q. sessiliflora* by its leaves having very short *petioles* or foot-stalks, as compared with those of the leaves of the other kind (see fig. 65), and by the stalks of the fruit being elongated, as represented in fig. 66.

608. *Economic uses of timber.*—Although oak timber is not now much required in the construction of ships of the line, still it is largely used for the building of our small coasting vessels; and a

very large quantity of the smaller sizes of trees is used annually in our mining operations. Besides these, oak timber is used for a great variety of purposes in connection with house-building, agricultural erections and implements. In short, the uses of oak timber are so numerous and so well known, that it would be superfluous to name them here. Perhaps the timber of no other tree we grow is so durable as that of the oak; hence it takes the first place among our hard-wooded sorts for economic purposes. The only tree that may be said to surpass it in paying value as a crop for the sake of its timber is the larch.

Fig. 65.

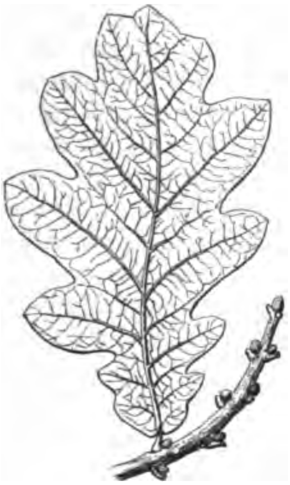
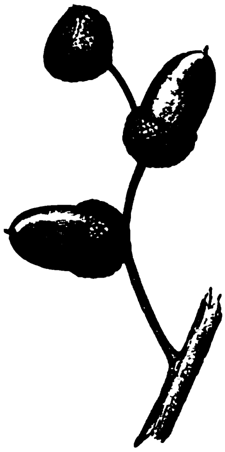


Fig. 66.



609. *Soil and situation.*—The rate of growth and quality of oak timber, like those of all other trees, depend very much upon the nature of the soil and situation upon which it is grown. We have paid great attention to this point during the last twenty years, and from experience and extensive observation during that time as to the character of land and situation upon which the oak flourishes best and attains its largest development and best quality of timber, we are led to state, as the result of our observations, that the best-grown oak-trees are to be found on a heavy, deep clay soil, or heavy loam of a deep description, into which the roots can get well down without any check from a change in the character of the subsoil. We find, however, that the oak will thrive on most soils, even on those of a very light nature; but in all cases, as we have already stated, the largest trees and the best quality of timber are found on lands of a deep and heavy character. On a light loam we have seen good timber of *Q. pedunculata* produced. On this description of land we have

seen trees from 12 to 18 feet in circumference of stem; but under these circumstances as to soil, the trees are generally found short of stem and large-headed in proportion; while trees of the same circumference of stem, and grown on deep heavy land, carry their stems very much higher, and therefore form more proportionate and ornamental trees. On high-lying and exposed situations the oak will grow, and even become timber of useful size, although the soil be but poor; but to produce oak of the best description, whether as to the dimensions of the tree or quality of its timber, it must be planted on rather a low-lying part, and on a heavy or loamy soil.

610. *Propagation and culture.*—The oak is raised from seeds, which are named acorns. These generally ripen in the month of November; and as soon as they are ripe, they should be gathered and sown immediately, because they are very apt to be injured by being long kept, more especially if they be not kept dry and in a cool place. If kept perfectly dry and cool, the acorns may indeed be preserved all winter and sown in the spring; but as they are extremely apt to be injured by careless keeping, the better way is to sow them at once when gathered, and we always adopt this plan.

611. In sowing the acorns, our plan is, as soon as we have them gathered, to sow them in rows upon the surface of the ground, which we have previously dug and prepared, and cover them with about 2 inches of earth. In sowing them, we mark off the rows about 15 inches distant one from another. The breadth of the seed in the row may be about 5 inches, and the seed may average 1 to every 3 square inches. In covering the seed, we gather up the earth from the ground upon each side of the row that is sown, until it is the desired depth upon the acorns, taking care not to come too near the seed upon the sides of the row, but keeping it there rather heavier of earth than above; for it is generally upon the sides of the rows that vermin make their attacks upon the seed.

After the acorns have been sown, they must be paid attention to, to see that vermin do not attack them. In the winter season, if mice or rats are in the neighbourhood, they will be certain to attack them; and if they do, traps must be used in order to destroy them. And in the spring months, if pheasants or any other birds commence upon the acorns, nets may be used in order to cover the rows from them; or if these be not upon the place, they may be covered pretty closely with the branches of trees, which will keep back birds, and at the same time allow a free circulation of air to the surface of the earth. This we have frequently had to do ourselves, and found them to answer the purpose very well. As soon as the young plants appear above ground, which will generally be about the end of May, the branches should be removed in order to give the young plants all justice, and great attention should be paid to keep them clear of weeds.

Our experience in the cultivation of the oak now leads us to state that the plants should only stand one year in the seed-rows: when left longer, they become drawn up and comparatively weakly. We now therefore invariably adopt the plan of planting them out in rows when one year old; and when the plants thus treated have stood three years in the lines, they are very much superior to others left two years in the seedling state, and that have stood two years in the nursery rows, both being of the same age. They should next be transplanted into the open nursery-ground, into rows about 2 feet separate, keeping the plants in the rows about 4 inches from one another; and in this state they may remain for a length of time, according to the size that the plants may be required—that is, if the plants are not wished to be large, two years in the rows may be enough, but in no case less; and if the plants are required to be large, three and even four years may be no more than sufficient.

The oak, the first year after being transplanted, makes very little progress, merely establishing its roots in the ground. The second year it sends out new shoots, and the third grows vigorously.

612. It would be superfluous to enter into detail of the many fine specimens of the *Q. pedunculata* that are to be found in the parks of the landed proprietors of Great Britain, and especially of those in many parts of England. There are few estates of long standing in the country that cannot boast of a few fine old specimens of oak-trees in their parks; and therefore it would, we think, be out of place to refer to any one in particular.

QUERCUS SESSILIFLORA, or the Sessile-flowered Oak.

613. *Specific character.*—Leaves deciduous, oblong, smooth, dilated upwards, stalked; lobes obtuse. Acorns in clusters of from 2 to 5; generally sessile, sometimes on short peduncles.

614. The above is the distinguishing character of this species, botanically speaking; but as it would not be sufficiently distinct for the distinguishing of it from the other species, *Q. pedunculata,* were the two laid before a person unacquainted with botanical terms, we will illustrate the subject by reference to a woodcut or two. It will be observed that the two most distinguishing characters of each of the two species of our British oak that have been referred to are—the leaves of *Q. pedunculata* have very short petioles (see fig. 65), while the fruit has pretty long foot-stalks (see fig. 66); again *Q. sessiliflora* has its petioles pretty long (see fig. 67), and the fruit entirely without stalks (see fig. 68). These, let it be understood, are the

most prominent distinguishing characters of the two species, but they are not always to be relied on; for even in examining a number of leaves upon the same tree, we find some of them that will answer to both species. But, generally speaking, these differences between the two kinds do hold good to a great extent; and an experienced person who has been long in the habit of examining the leaves of each species, can at once, even from the forms as already explained, point out the different sorts. But besides this, there is another mark of distinction, which is even more decided than the marks taken from the fruit and leaves—namely, that from the buds upon the young wood. The buds upon the *Q. sessiliflora* are more prominently brought out upon the wood than those of the *pedunculata;* and the wood at the base of the buds is also more fully developed. See fig. 67, where a piece of the young wood is shown; and compare the buds as shown there with those upon the young shoot in fig. 65, which represents a piece of the young wood of the *pedunculata.* As in fig. 65, the young wood swells but slightly at the base of the buds, and this is generally the case with the *pedunculata;* whereas in fig. 67 the young wood swells boldly at the same point, and this is generally the case in the *sessiliflora.* The distinguishing characters that have been pointed out are, however, very often blended together in one tree. But this is easily accounted for by the two species having been long growing together in the country, from which have arisen many trees which are no doubt what may be termed hybrids between the two. When, however, we do find the trees distinctly developing each its own characters, the marks given will hold good, and point out which are the original sorts and which are hybrids.

Fig. 67.

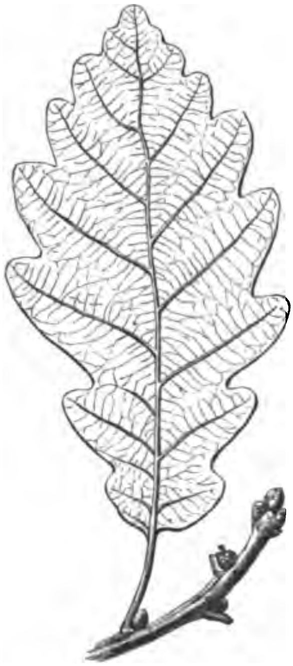
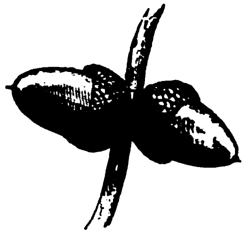


Fig. 68.



615. *Geography.*—The *Q. sessiliflora* is dispersed over the same range of countries as the *Q. pedunculata,* and they are generally found growing together from Sweden southwards to the Mediterranean. It is found largely in Britain along with the *pedunculata,* in France as well, and forms a large portion of the oak-forests of Germany. It is

said that in Germany the *sessiliflora* grows to valuable timber on a greater variety of soils than the *pedunculata* does, and that therefore it is much cultivated for its timber there.

616. *Description of tree.*—As to magnitude of timber, the two species grow nearly alike; but we have generally observed, in respect to the *sessiliflora,* that it takes a more open and upright habit of growth than the *pedunculata.* The limbs of the *sessiliflora* are not generally so *knee-bent* and *gnarled* as those of the *pedunculata,* and trees of the former kind have in all respects a lighter aspect than those of the latter.

617. *Economic uses of timber.*—For all purposes to which oak timber is applied, that of the *sessiliflora* is used as plentifully as that of the *pedunculata,* and in old buildings its durability has been found to be equal to the timber of the other kind. When young, the timber of the *sessiliflora* is of a more open texture than that of the *pedunculata* of the same age, but as it becomes older it is found as compact and solid as that of the *pedunculata.* This arises from the tree being of a more free growth in its young stages than the other is.

618. *Soil and situation.*—These are in all respects the same as has been stated in reference to the *Q. pedunculata* at paragraph 609. It may be remarked here, however, that the *Q. sessiliflora* makes a much better hedgerow tree than the *pedunculata* does; because in such a situation it maintains more of an upright habit of growth than the other, and is easier kept from spreading out its branches over the land than it.

619. *Propagation and culture.*—For this tree these are the same as recommended and described under paragraphs 610 and 611.

QUERCUS CERRIS, or Turkey Oak.

620. *Specific character.*—Leaves on very short stalks, oblong, deeply and unequally pinnatifid; hairy beneath; lobes lanceolate, acute, somewhat angular. Stipules longer than the foot-stalks. Calyx of the fruit hemispherical, bristly.

In order to make this description more clear to the general reader, figs. 69, 70, and 71 are given to represent the form of the leaf; that of the seed with its bristly calyx; and that of the stipules on the young wood.

621. *Geography.*—The *Q. cerris* is a native of France, Italy, Spain, Austria, and the west of Asia, and was introduced into Britain about one hundred and fifty years ago.

622. *Description of tree.*—This oak is, as well as the common British ones a deciduous tree, growing to about the same height—

viz., from 50 to 100 feet, according to soil and situation. It is, however, a much more rapid-growing tree than either of the sorts

Fig. 69.

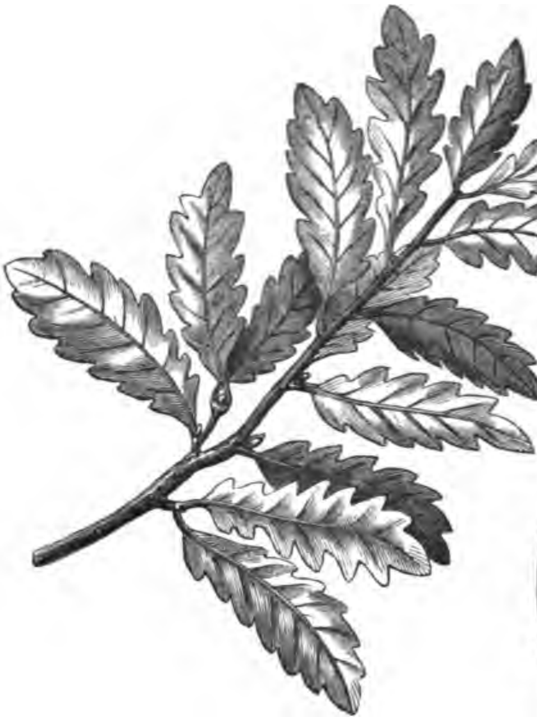


Fig. 70.

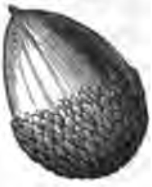


Fig. 71.

described, and is found to stand the climate, and grow well in Britain. It forms a beautifully-spreading and partly drooping branched tree standing singly on a park, and is indeed very ornamental among other trees of a more upright habit of growth; but it does not resist storms or high winds well, as in such circumstances it is very apt to have its limbs injured and broken.

623. *Economic uses of timber.*—The Turkey oak has not been long enough nor extensively enough cultivated in Britain to enable us to have matured specimens of the wood for economic purposes, and therefore as yet we have very little experience as to the qualities of it. We have ourselves, however, had various specimens of this sort cut down in the work of thinning plantations on various places, and have had them cut up and used for various purposes in connection with fencing and other estate works, but have in all cases found the timber for such purposes inferior to that of the sorts already referred to. It is said,

however, that the matured timber of *Q. cerris* is much finer in the grain than that of either of the British oaks. It is said to take a better polish, and to be much prettier than those in the graining. It is admitted, however, by most people who have seen the timber in its matured condition, to be inferior in strength to that of the British oak, and that when the tree becomes matured it is very apt to get shaky. In Turkey the timber of this oak is largely used in ship-building and in house-fitting.

624. *Soil and situation.*—The *Q. cerris* thrives well in most dry loamy soils; but in all cases, to grow the tree well, the land on which it is planted must be deep and dry. It thrives best on rather sheltered and warm districts, and worst on bleak exposures with a poor soil.

625. *Propagation and culture.*—The tree ripens its seeds, on the average of years, well in Britain, and especially in the midland and southern counties of England, where a supply can generally be had, and from which plants are raised in the same way as those of the common British oak. Plants raised from the seed are very apt to sport—that is, to run off into varieties somewhat different, either in leaf, in seed-calyx, or in the general habit of the whole tree; and when a certain variety is wanted to be extended, it is generally increased by grafting either on stocks of the same species, or on the common British oak. In fact, it is principally by grafting that this tree is propagated, as by this mode nurserymen find they can produce the exact variety wanted, and there are many of them in cultivation.

626. On most places of any importance in Britain we find the *Q. cerris* planted in the parks, and generally attaining considerable size in the course of a few years. In England the tree is common not only in the parks, but in many of the woods and plantations as well, where it thrives rapidly, and becomes a tree of very considerable size within a period of forty years; when in height and general dimensions it far surpasses the British oak of the same age, growing on the same land along with it.

QUERCUS ILEX, or Evergreen Oak.

627. *Specific character.*—Leaves ovate-oblong, acute, coriaceous, entire or serrated; hoary beneath. Bark even. Nut ovate. Figs. 72 and 73 will more clearly show this to the inexperienced in botanical terms. This kind also is apt to run into varieties, and of these there are many in cultivation, but to them we need not refer.

628. *Geography.*—The *Q. Ilex* is a native of the south of France, and of Spain and Italy. It is said that this tree does not, in its

natural state, grow in masses, but is for the most part dispersed here and there among other trees. It is said to abound on the hills in Sicily, all along the coast, and to ascend Mount Etna as high as 3200 feet above the level of the sea, and within about 800 feet of the elevation of where *Q. cerris* is found. Indeed the truth of this is borne out by our experience of the hardiness of the tree as growing in Britian; for it is found to be remarkably hardy, and to grow well close to the sea-shore, where no other European oak will thrive.

Fig. 72.

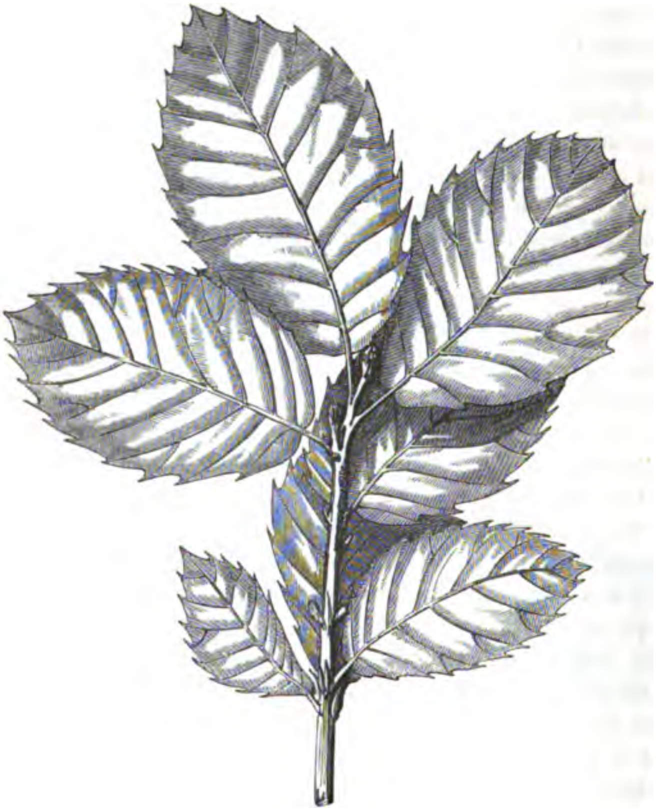
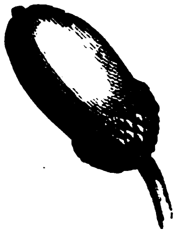


Fig. 73.



629. *Description of tree.*—In favourable situations this tree attains considerable size, both in its native countries and in Britain and Ireland; but, generally speaking, at best it forms merely a large bush in the latter countries, only in a few cases attaining what may be called timber size. But it has one advantage in point of ornament—namely, it becomes clothed from the ground to the top with a dense mass of branches and leaves, which give it a peculiarly striking and ornamental effect. This is when it stands alone and

unencumbered; for we have seen it form a clean stem of some dimensions when confined among other trees. The leaves of this tree vary much in shape and size, thus giving rise to named varieties—such as *latifolia*, broad-leaved; *crispa*, curled-leaved; *oblonga*, long-leaved, &c. &c. The colour of the leaves is a dark green; and from their being convex above, and quite smooth, they give a pleasing shining appearance to the tree as a whole. In favourable parts of Britain, say the south of England, trees raised from seed grow very rapidly, often attaining a height of 20 feet in twelve years; but in Scotland they grow much more slowly, seldom attaining over 10 feet in as many years. This tree is said to live to a great age, and to continue in a healthy growing state for several centuries.

630. *Economic uses.*—The matured heart-wood of the *Q. Ilex* is of a very close grain, very hard and heavy—so much so as to be very difficult to work. The young wood is, however, comparatively soft, and easy to work. In Britain it has not been made much use of; but we have cut down several trees of it, of some sixty years' standing, and found the wood very hard. Those trees that we have felled were used for furniture purposes, and we found the timber took on a very fine polish, and had every appearance of being of a very durable nature. On the Continent, where it grows extensively, it is said to be much used for furniture-making and for charcoal.

631. *Soil and situation.*—The *Q. Ilex* thrives best in a light, dry, deep soil. Indeed it will not succeed unless the soil is deep, free, and open; and if it be at all wet in the subsoil it will become sickly, and fail to grow satisfactorily. The soil on which it grows best is one of a sandy nature rather than a clay or a loam; and where it is wished to have the tree of a good size, it should be planted in rather a low-lying and sheltered part.

632. *Propagation and culture.*—This tree is propagated chiefly from the acorns, which are generally procured from the Continent. The varieties are extended by grafting and layers. As the plants run to tap-roots, and are difficult to transplant safely, nurserymen generally rear them in pots, as by this mode the roots are at the command of the cultivator, and the plant can be safely transplanted at any time. We know of no tree so difficult to transplant with success, as the roots go down so deep into the subsoil, and are so badly supplied with fibres, that it seldom succeeds without a very careful and systematic previous preparation.

QUERCUS COCCINEA, or Scarlet Oak.

633. *Specific character.*—Leaves smooth, oblong, deeply and widely sinuated, on long stalks; lobes divaricated, acute, sharply toothed,

bristle pointed. Calyx of the fruit turbinate, half as long as the nut.

634. *Geography.*—The *Q. coccinea* has been long cultivated as an ornamental tree in this country, and is well known from its beautiful shining green leaves, which in early autumn become of a brilliant scarlet. This tree is very abundant in the State of New Jersey, United States, where in the autumn we have seen it in a perfect glow of scarlet, giving a character to the foliage of the woods which is indescribable, and cannot be understood unless seen. We have met with it in Canada as well, about the shores of Lake Ontario, but it is not nearly so common there as in the Northern States of the Union.

635. *Description of tree.*—The scarlet oak in America grows to a large size—sometimes, under favourable circumstances, to 80 and 90 feet high, with a stem from 2½ to 4 feet diameter, according to soil and situation. The bark is generally of a dark colour and very thick, and the wood, when cut up, is of a coarse description, and open in the texture. The leaves are generally of a large size, and vary much in shape—sometimes nearly entire, and in other cases very ragged. The latter form of the leaf is generally found on oldish trees, and the former on young ones. The tree is of an open habit of growth, and is highly prized on account of the beautiful scarlet of its leaves in autumn. It is perfectly hardy in Britain, on some favourable situations forming trees of very considerable dimensions of timber.

636. *Economic uses.*—The wood of the *Q. coccinea* is almost of no economic value: it is so porous and open of texture, even when old and grown in America in its natural soil, that no one esteems it for any purpose except that of making staves for dry-goods barrels. It does not even make a fair firewood. This tree is therefore only cultivated as an ornamental object, and it is admirably adapted for this, as no tree is prettier to look on in the autumn when its foliage takes on its scarlet hue.

637. *Soil and situation.*—In Britain this tree thrives best on a rather light dry soil: on heavy cold clays it does not succeed. In America it grows on a great variety of soils,—even on the *débris* of rocks we have found it a tree of fair size; but the best specimens are generally found there, as here, on deep, light, dry soils, with a warm and sheltered site.

638. *Propagation and culture.*—The acorns of this species are imported from America, and raised in the same way as those of the British oak. As stated above, this cannot be said to be a tree worth cultivation for the sake of its timber; still, as an ornamental tree, there is not any other that can compare with it in the beauty of its foliage, and it is for this reason we recommend it.

QUERCUS ALBA, or White American Oak.

639. *Specific character.*—Leaves oblong, deeply pinnatifid, glaucous beneath; lobes linear, oblong, obtuse, entire, dilated upwards. Fruit stalked. Calyx depressed, warty, hemispherical. Acorn oval. Introduced in 1724.

640. *Geography.*—The *Q. alba* is plentiful in Canada, and in the Northern States of America generally, where it grows to large dimensions on most of the better parts of the land, and especially where the soil is rich, light, and dry. We have ourselves found this tree very plentiful in the upper parts of the valley of the Madawaska river, a tributary of the Ottawa in Canada West, and we have always found it on rich lands and seldom on poor.

641. *Description of tree.*—In looking at a well-branched specimen of the *Q. alba,* it resembles very much the British species *Q. sessiliflora,* only on good land the leaves are larger, with more deep sinuosities. The bark of this tree is of a whitish colour, and from this circumstance the tree has derived its name. The colour of its bark is a feature in the appearance of the tree sufficient to enable any one to distinguish it from all other oaks. In its native forests the *Q. alba* forms a grand tree, and is considered the best of all the American oaks in respect to the value of its timber. On the valley of the Madawaska we have seen specimens of this tree measuring from 60 to 70 feet of stem clear of branches, with a diameter of 4 feet at 30 feet up from the ground. These trees, when standing, measured about 110 feet high, and when cut down we found several containing each upwards of 500 cubic feet of timber. On examining the cross sections we found them upwards of 400 years old.

642. *Economic uses.*—As already stated, the white oak is one of the most valuable of the genus in America. It is largely used in house-building, and in fact for most purposes it is in use there, from shipbuilding to handle-making. A large quantity of it is exported from Canada to Europe, and is well known under the general name of American oak.

643. *Soil and situation.*—To grow this tree well in the British Isles, it requires to be planted in a rich, deep, light loam, and in a sheltered part of the country, as it will not prosper on a poor soil or on an exposed situation. It is perfectly hardy, however, and will grow on most soils and sites not too poor nor too much exposed; but to grow it to any size of timber it must be placed on a good soil and warm site.

644. *Propagation and culture.*—This species is for the most part propagated from seed brought from America, and as this can now be easily obtained it is found of easy propagation. The seed, as soon

as brought home, should be sown in all respects in the same way as has been described in respect to the propagation of the *Q. pedunculata*. This species, however, is not prolific in the production of acorns, and therefore the seed is always high-priced. In after-cultivation the *Q. alba* is dealt with in all respects in the same way as the British oaks. This tree has hitherto been too little grown in this country; and looking at it in the light of its timber alone, independent of its ornamental qualities, it deserves to be more extensively introduced than it has been.

645. On many places in Britain, and especially in the midland and southern counties of England, many fair specimens of this tree are to be found; and even in Scotland the tree seems to thrive well, attaining in many cases dimensions equal to the British oaks in a given time.

SECTION III.—THE ASH (FRAXINUS)—LINNÆAN SYSTEM, POLYGAMIA DIŒCIA.

646. *Character of genus.*—Flowers diœcious. Hermaphrodite—calyx none, or 4-parted; corolla none, or 4 petals; stamens 2; samara 1-seeded. Female—calyx none, or 4-parted; corolla none, or 4 petals; samara 1-seeded.

647. There are many distinct species of the ash, the greater number of them being natives of North America; but all of them, in our country, attain, under the most favourable circumstances, very inferior dimensions as compared with the *Fraxinus excelsior*, or common ash, which is a native of Britain, and one of the most useful of our hardwood timber-trees for general purposes. We shall refer to it only, as none of the other species is adapted to cultivation as useful and profitable timber with us.

FRAXINUS EXCELSIOR, or Common Ash.

648. *Specific character.*—Leaflets somewhat stalked, lanceolate, acuminate, serrated, smooth, cuneate at base. Branches flat, smooth. Flowers naked. Samara obliquely emarginate at the apex. The leaves have generally five pairs of leaflets, but sometimes six. The flowers are produced in loose spikes from the sides of the branches. On some there are only female flowers; on others, hermaphrodite ones; and on others, male ones; while on some trees the flowers are found in two of these states, or in all of them.

649. *Geography.*—The common ash is indigenous to Sweden, Norway, Russia, and the south of Europe, and is said to be found also in the north of Africa. In Britain it is found growing naturally in

many places, from the north of Scotland to the south of England, and almost in all cases on good deep soil, and seldom on exposed sites and poor soils.

650. *Description of tree.*—The common ash is undoubtedly one of the grandest of our forest-trees, whether it is found in a plantation or on a park. Many object to the ash being introduced into modern landscape on account of the lateness of the tree in coming into leaf, that being generally about the first week of June, by which time most other trees are in almost full leaf, itself standing alone bare, and apparently in winter. This objection is, in our opinion, very superficial, and of little weight; for this very peculiarity of the tree gives it an interest in the eye of refined taste which is not to be found in any other tree; for what is more pleasing than to see, at a time when all other trees are in full leaf, the ash first swelling its large black buds, and unfurling its leaves to the summer's sun? Another objection formed against the introduction of the ash into the park is, that it is the first tree to lose its leaves in the autumn. This is indeed true; but even when the tree is newly stripped of its leaves, its appearance here and there as a leafless naked tree contrasts well with the masses of sickly foliage upon the adjoining trees. Apart, however, from the lateness of the tree in coming into leaf, and its being suddenly stripped of its foliage in the autumn, the ash is to be admired as a stately proportionable tree, and is well worthy of a place in every British landscape. The foliage of the ash is of a beautiful light-green colour, and is what is termed *pinnate*, or winged (see fig. 74); and the young shoots are *flattened*, of a very brittle texture, and are furnished with very prominent dark-coloured buds (see fig. 75).

The natural habit of the ash is that of a tall tree of first-rate magnitude, but inclined to grow tall rather than to great girth of stem. In plantations of a moderate thickness, this tree is extremely apt to run up to a great height without taking a proportionate girth along with its height; but when the plantation in which it grows is kept rather thin and airy, the side branches are easily checked, and excellent tall timber is formed. When growing in a park or open lawn, the ash forms a large-headed tree of imposing effect; and in this case a large stem is generally formed, quite in proportion to the massy top.

651. *Economic uses of timber.*—There is, perhaps, none of our forest-trees the wood of which can be applied to so many different useful purposes as that of the ash. As to its toughness and elasticity, no tree grown in our woods can be compared to it. As an example of this property, it is only necessary to look to the articles made from it by the sievewright and the basket-maker, in whose hands ash-wood bends like a piece of wire. The value of ash timber is always in-

creased by the rapidity of its growth, and is in its most useful state when comparatively young, and not much over sixty years old. The timber is much in use by the coachmaker and cartwright, and in many parts of agricultural machinery ash is still much used. It is particularly valuable, in its young stages, for hop-poles, hoops, crates, handles, and for fencing purposes; and in many parts of England ash-coppice is cultivated to a large extent for crate-wood, for packing up articles manufactured at the potteries.

Fig. 74.

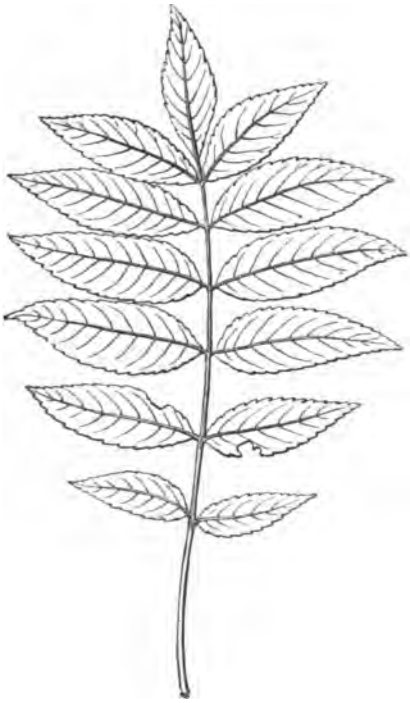
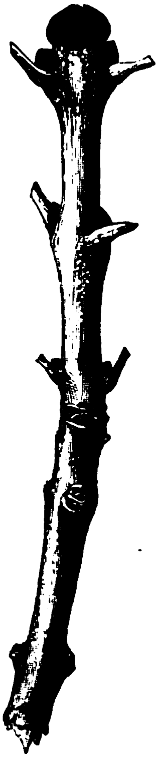


Fig. 75.



652. *Soil and situation.*—The ash is in all respects a hardy tree, and accommodates itself to most soils and situations not too high-lying and exposed; but to grow it to large dimensions of timber, and to have that of good quality, the tree must be planted in a rather low-lying situation, and on a strong loamy soil, but not a retentive one, nor on one wet in the subsoil, as, although the ash agrees with a moderate degree of moisture, still the land on which it grows best is in all cases found to be porous, deep, and free from stagnant water in the subsoil. There is no situation so well fitted for the profitable growth of the ash as the sides of ravines, having a good strong loamy soil, where there is a constant supply of water for the roots from the

ground above; and even in such cases the best and largest trees will be found on the lower parts, where there is most shelter and the strongest soil.

653. *Propagation and culture.*—The ash is propagated by seeds, and varieties are extended by grafting and budding on plants of the same species. The seeds are enclosed in what is termed *samaras*, or keys, which are generally ripe for gathering about the end of October. When gathered for the purpose of sowing, the seeds should be mixed with a quantity of dry sand or light dry earth, in which they should be kept for eighteen months, in order to rot off the outer coat; and in order the more effectually to insure this, the whole mass of seeds and sand should be turned every three months. This mass of sand and seed should not be much over 1 foot in depth, as, if more, it will be liable to heat, and in consequence the vitality of the seed would be injured. In the second March after they are gathered, the seeds should be sown in rows rather thinly, and upon any moderately well-pulverised soil. They are sure to come up thickly, and confine one another, if not sown thin—say one seed to every 3 square inches; and the covering of earth should not exceed ¾ of an inch. In the following spring the plants will be ready for being transplanted into the nursery-rows, which may be 15 inches one from another, and 4 inches plant from plant in the rows. When the plants have stood two years in the nursery-rows, they may be removed and transplanted into the forest-ground; but if wanted of a larger size, they may be left a year longer.

654. In duration the common ash-tree is superior to many of our hardwood trees, there being instances of them over 300 years old in several parts of the country; and upon many estates there are ash-trees known to be upwards of 200 years old, and yet apparently in health. In England there are many fine specimens of ash; for example, at Longleat, in Wiltshire, there are several trees having clear stems of nearly 50 feet, and which measure from 10 to 14 feet in circumference. On many other places both in England and Scotland, there are fine specimens of old ash-trees, some of them measuring from 15 to 20 feet in circumference of stem, with proportionate tops.

SECTION IV.—THE ELM (ULMUS)—LINNÆAN SYSTEM, PENTANDRIA DIGYNIA.

655. *Character of genus.*—Flowers pentapetalous, inferior. Capsules closed, membranous, compressed, bordered, superior.

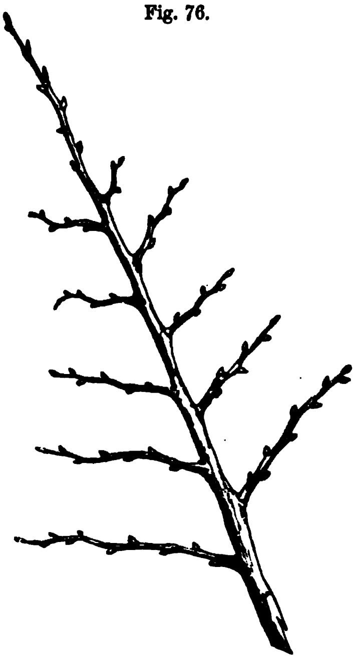
656. There are several species of elm, from the dwarf sort, *Ulmus pumila,* a native of Siberia, which grows only some four feet high, to

the *Ulmus campestris,* or English elm, which often grows to the height of 100 feet. There are also several species, natives of North America, which in their native climate form large trees, but which are not suited for cultivation as timber in Britain, but merely as ornamental specimens of their kinds in our pleasure-grounds. We shall refer to two species only—the *Ulmus campestris* and the *U. montana*—as these are the two principal ones for profitable cultivation in Britain. Therefore we will commence our observations on these with the first-named.

ULMUS CAMPESTRIS, or common English Elm.

657. *Specific character.*—Leaves doubly serrate, unequal at base. Flowers subsessile, clustered 5, androus. Fruit smooth.

Fig. 76.



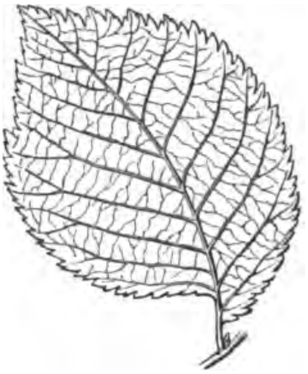
The English elm is easily distinguished from the *U. montana,* or Scots elm, by having the young shoots of a slender form, and those of the last year springing alternately upon each side of the preceding young shoots (see fig. 76). The leaves also all spring from the young shoots in an alternate manner; and when these are off in the winter season, the slender and irregular appearance of the young wood contrasts beautifully with the rugged appearance of the bark upon the old wood, and gives the branches altogether a light and airy appearance. The leaves (fig. 77) are small as compared with those of the *U. montana:* they are doubly serrated, rough and hard to the touch, and of a beautiful dark-green colour, and unequal at the base, which is a particular characteristic of all the different species of the elm.

658. *Geography.*—The *U. campestris* is indigenous to the middle and southern parts of Europe, and to the west of Asia. It is found very plentifully in France and Spain, and is generally believed to be a native of England as well. That it is so is doubted by many, however, from the fact that the tree very seldom ripens its seeds in Britain, that occurring only in very favourable seasons.

659. *Description of tree.*—This tree, next to the oak, is the most

generally cultivated for ornamental purposes in England, where it is found in great perfection, adorning the parks and lawns of landed proprietors. It is also a very common hedgerow timber in many parts of England; as, for instance, in the valley of the Severn, where it may be seen in great perfection. It is generally admitted to be one of the tallest and finest of our European timber-trees for park scenery, and lives to a considerable age. In favourable situations this tree grows rapidly, sometimes attaining so much as 25 feet in height when only ten or twelve years planted. The general character of the tree is that of a tall, upright habit of growth, with a straight stem, generally from 3 to 5 feet diameter when of mature age, while the branches are slender in proportion to the diameter of trunk.

Fig. 77.



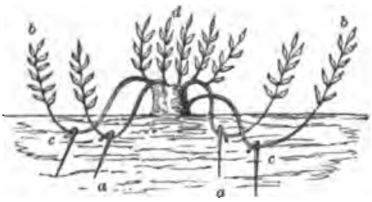
660. *Economic uses of timber.*—The timber of the *U. campestris* is particularly strong in what is termed lateral fibre, but is deficient in longitudinal adhesion of fibre. Its strength in lateral fibre fits it admirably for the making of blocks and dead-eyes for the rigging of ships, and for this purpose it is much used. It is very much used also in the shape of naves for wheels, and a good deal of it is used in furniture-making. In short, the timber of this tree is used in England for a great variety of purposes in connection with rural affairs—such as troughs for conveying and retaining water, and for supporting the banks of water-courses, &c.

661. *Soil and situation.*—This tree attains its largest dimensions on a deep, rich, and dry loam—not of the character of clay nor of that of sand or gravel, but of a free, open loam. The tree will indeed grow and prosper on most ordinary lands, if they are dry; but to have it in perfection, the land must be of a good, deep, dry character.

662. *Propagation and culture.*—In the southern parts of Europe the *U. campestris* is raised from seeds, and plants are often procured from these, and especially from the south of France; but in this country, where the seeds seldom ripen, we have either to import the seed or propagate the tree by suckers from the roots of the old trees, which are had in abundance; or by layers, which is the method by which plants of the true kind are procured, and the plan still adopted in many public nurseries for the propagation of this tree; and in this place it may be proper to show how the work is done.

The process of layering consists in having, first, a piece of ground planted, at about 6 feet apart, with plants of the English elm, or any other tree that it may be desirable to propagate in this way. When these have stood for three or perhaps four years, in order to gain sufficient strength, they are cut over to within three or four eyes of the ground, in the same manner as a bed of osiers. When the eyes have pushed out shoots of one year's growth, they are in the autumn, when these shoots are ripe, fit for layering. In layering the shoots which are meant to become young plants or trees, all the ground about the plants is dug and made perfectly clean from weeds, all stones being also taken out. When the ground has been thus prepared, the young shoots are bent down regularly round the parent stool (see fig. 78) into the earth, and are kept in their places by small wooden pegs *a a*, and covered with soil about 4 inches deep at the part bent into the ground. The top part of each shoot *b b* is turned up in an upright direction out of the soil, and in a few months the part which is buried in the soil *c c* takes root, when of course each shoot becomes a perfect plant in itself, and may be removed in the autumn following with all the fibrous roots attached, when they are planted out in nursery-lines, in order to gain more strength before being put out into the forest-ground. Great care must be observed in cutting away the young and newly rooted plants from the parent stem; and before the spade is put into the ground in order to loosen their roots from the soil, they should all be cut away from the parent by using a sharp knife, taking care not to pull up the shoot in the act of cutting. When the young plants have been all taken away, the stools should have all the stumps of the branches which were cut off taken away, and young shoots will proceed from the cut parts the following spring, which again will answer for layers in the autumn, as at *d*. This process goes on successively: each summer's shoots which rise upwards are in the autumn laid down in order to become new plants; and while these are in the act of making roots, the parent stool is again employed sending up a new supply of shoots to succeed them. When a severe drought sets in, the ground should be liberally watered in order to encourage the rooting of the young plants.

Fig. 78.



In England this tree attains large dimensions. For example, at Sion House, Isleworth, in the neighbourhood of London, there are specimens upwards of 100 feet high, with stems from 5 to 8 feet in diameter, forming large and spreading tops of grand and imposing aspect. In Kensington Park also, in the immediate neighbourhood of London, there are many handsome specimens of this species, several of them being upwards of 100 feet high, with stems from 5 to 6 feet in diameter. At Longleat, Wiltshire, there is a specimen 120 feet high, with a circumference of 20 feet at 4 feet from the ground.

ULMUS MONTANA, Scots or Wych Elm.

663. *Specific character.*—Leaves doubly serrated, unequal at base. Flowers 6—8, androus, stalked. Fruit fringed at base.

The Wych elm is easily distinguished from the *U. campestris* by the greater size of its leaves: these are what is termed *rough* and *broad*, with a longer point, and are more deeply serrated than in the other species (see fig. 79).

The young shoots are much stronger, and altogether more massive, than those of the *U. campestris* (see fig. 80), and are slightly downy in their first stages. Another distinguishing character of the Wych elm is its producing no suckers from its roots, which all the varieties of the English elm constantly do: by this it is easily known, independent of any other peculiarity.

Fig. 79.

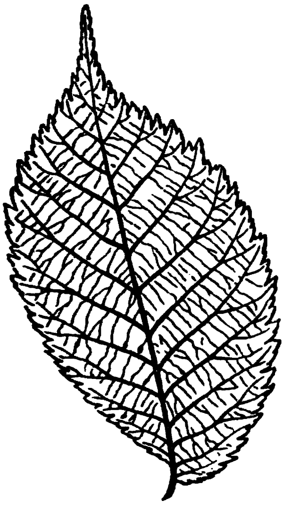
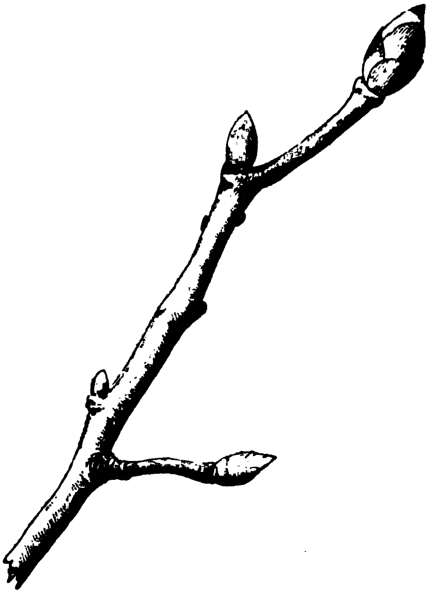


Fig. 80.



664. *Geography*—The *U. montana* is a native of Britain and of other parts of Europe, and is cultivated in Scotland more than

the English elm is. It is cultivated extensively in Ireland as a timber-tree; but in England, and on the continent of Europe, it is not much cultivated, the *U. campestris* being preferred in those parts.

665. *Description of tree.*—The Wych elm forms a large-headed spreading tree, having its limbs strong and diverging, which gives it a magnificent appearance among other trees of a stiff character; and when the tree has arrived at full maturity, the branches, from their great weight, incline to hang down in a drooping position at the extremities, forming rich festoons when in full leaf. This is the habit of the tree when grown upon an open park, with free air to develop its branches; but in such a position it seldom attains to its greatest height and magnitude as a timber-tree. When grown in the forest, and where it has not so much free room to extend its side branches, its diverging habit is checked; but in such a position we almost always find it contains the greatest quantity of available timber, and forms a tree of first-rate magnitude. The *U. montana* is of much quicker growth than the *U. campestris*, and indeed is generally of a very rambling habit in its young stages, and till it gets its leader fairly on the ascendancy: afterwards it grows more upright, and soon attains considerable height. This tree, when left to itself in an open park, forms one of the most picturesque and beautiful imaginable. It may, indeed, often be surpassed by its neighbour the English elm in regard to its height and cleanness of stem, but it cannot be surpassed in the general effect of its outline. It in all cases stands unrivalled upon the lawn, its appearance being altogether natural, light, and easy. The English elm has a stiff, unbending outline: the Wych elm is the opposite of this.

666. *Economic uses of timber.*—In Scotland the wood of this tree is much sought after for all country purposes—such as cart and waggon shafts, plough swing-trees, cart-naves, wheel-barrow and cart framing, &c., &c.; indeed there are few purposes to which ash is generally applied, for which elm is not used instead when that wood cannot be got conveniently and of good quality, and for these it is well adapted from the toughness of its longitudinal fibre. Large quantities of this kind of elm timber are used for railway purposes, and especially for handles for implements used by the workmen in connection with them. In England the timber of the *U. montana* is not much used, that of the English elm being generally preferred together with that of the ash where toughness of fibre is required.

667. *Soil and situation.*—The *U. montana* delights in deep glens and ravines, on a deep open-bottomed soil, where it can get its roots down into the *débris* of rock, and where fresh moisture is

constantly passing along; but it does not succeed if its roots get into stagnant water. The largest trees we have seen of the kind were on the sides of a running stream, where the roots had access to the water without its lodging about them; and there the soil was a sandy loam, very open and porous. The tree likes, and always grows better in, a heavy soil than in a light one—that is, it will grow better on a stiff or clay loam than it will do on land of a very sandy or gravelly character; but it prefers soil of a medium description, as on such the best trees are always found.

668. *Propagation and culture.*—The Wych elm is propagated from seed, which is generally found very plentiful upon old trees from the end of May to the middle of June. The seed being very light, and easily blown about by the wind when fallen, it should, when ripe, be gathered by the hands from the tree, and not allowed to fall; and when it is gathered it should be sown immediately, as it will not keep long. It should be sown in rows 15 inches apart in the nursery, upon a fine light soil, and should not be covered to a greater depth than half an inch. The seeds spring up very freely and quickly, and will be ready for planting out into nursery-rows in the following spring: in planting them into rows, there may be about 20 inches between each, and the plants may stand in the rows about 4 inches from one another. When they have stood two years they will be ready for planting out on the forest-ground.

669. Fine specimens of the *U. montana* are to be found on many places. These are, indeed, so common in all parts of the country that it would be superfluous to refer here to any one in particular. Suffice it to say, that specimens from 80 to 90 feet high, with stems from 3 to 5 feet in diameter, are common in most parts of the country.

SECTION V.—THE BEECH (FAGUS)—LINNÆAN SYSTEM, MONŒCIA POLYANDRIA.

670. *Character of genus.*—Barren flower in a globose catkin; perianth single, campanulate, 6-cleft; stamens 5 to 12. Fertile flower 2, within a 4-lobed prickly involucre; perianth single, urceolate, with 4—5 minute lobes; germen incorporated with the perianth, 3-celled, two of them becoming abortive. Styles 3. Nuts one-seeded, invested with the enlarged involucre.

671. There are only two species of the beech—*F. sylvatica* and *F. ferruginea*—described in our catalogues of trees, the former being the common beech of our woods, and the latter a native of America; but there are several varieties of the former in cultivation in our nurseries. We will, however, refer only to the common beech, as it is the only species cultivated as a timber-tree in this country.

FAGUS SYLVATICA, or common Beech.

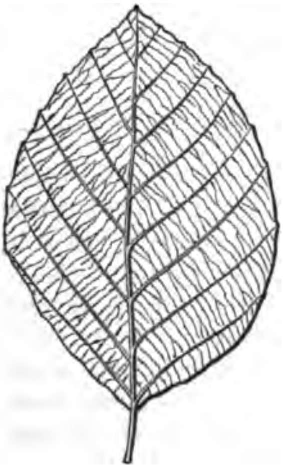
672. *Specific character.*—Leaves ovate, glabrous, obsoletely dentate; ciliate on their margins.

673. *Geography.*—The *F. sylvatica*, or common beech, is a native of most of the temperate parts of Europe, from Norway southwards to the Mediterranean, and eastward even to the west of Asia. It is plentiful in the southern parts of Russia. In Britain it is found plentiful, seemingly in a natural state of growth, on many parts, particularly in Dorsetshire and Berkshire, and more especially where the land is of a chalky description, such as on the chalk hills in Wiltshire and Hampshire. Whether it may be indigenous to Scotland is not satisfactorily accounted for; but be this as it may, the tree prospers well in all the southern and middle parts of the country, and even attains very considerable dimensions in some of the more northern parts.

674. *Description of tree.*—The common beech is a very hardy tree—one of our hardiest; for in Devonshire, where some parts are much exposed to severe west winds, no tree appears to stand so well, and that in high exposed situations upon a poor thin gravelly soil. In many high-lying parts of Scotland, too, where even the Scots pine has failed upon a thin soil, we have seen the beech grow and make an excellent shelter, and that near the sea-shore,—which points out that it makes an excellent tree for planting along the sea-shore as a protection for the more valuable forest-trees.

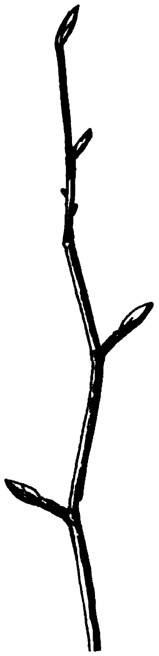
Besides the useful property of being a hardy tree, the beech is also an extremely ornamental one, and is often found of dimensions far surpassing the oak. It rises generally with a clear stem, with massy branches spreading almost horizontally; and when in full leaf, the tree has altogether a light and airy appearance, contrasting beautifully with the sycamore or horse-chestnut, which have a heavy sombre aspect. In duration as a tree, the beech is much inferior to the oak, sycamore, and chestnut.

Fig. 81.



The beech is a tree easily known from any other in the forest by its smooth bark and light-green silky leaves. The leaves are what is termed *ovate* and *obsoletely dentate*, being fringed on the margin (see fig. 81). The beech in its young state generally retains its leaves all winter till it is from 15 to 20 years old, when they drop them like any other deciduous tree; but if the beech be kept cut down in the form of a hedge, it retains its leaves all winter, so long as the plants exist in a healthy state—a remarkable feature in the nature of the tree, and one which characterises the beech as the best of all plants for a hedge where shelter is the object.

Fig. 82.



The young shoots of the beech are numerous upon the larger branches, and are rather slender in appearance, and of a somewhat brittle texture (see fig. 82).

675. *Economic uses of timber.*—The beech is not considered a timber of much value, as the wood is very brittle and short-grained, and not well adapted for purposes where strength and durability are required. At one time the wood of the beech was much used for machinery, particularly by millwrights; but since the extensive use of iron in all machinery, the beech is very little used for that purpose. The wood of the beech, when in a young state, is proverbially of short duration. However, the beechwood, when kept constantly wet, is remarkably durable, as is the case when it is made into water-wheels; but if it is kept constantly dry, as in the case of roofing in a house, it lasts but a short time as compared with many other sorts of timber. Beech, however, is yet much used for the following purposes: Framing for certain kinds of household furniture, panels for carriages, carpenters' planes, wooden bowls, granary shovels, and many small articles in turnery. It is also much used for making charcoal for colour-manufacturers, and we have disposed of large quantities of it in this way.

676. *Soil and situation.*—The beech will grow well on most dry light soils, and delights especially in a chalky land, even although that may be heavy and of a stiff nature, but will not succeed on land at all of a wet character in the subsoil. We have seen this tree form large specimens on most kinds of land, but the best and largest we have always found on a dry and rather light description of soil, having a considerable proportion of lime or chalk. However, although this is the case in regard to the beech, it is often found luxuriating, and forming excellent specimens and good quality of timber, upon lands of an opposite character—that is, upon a stiff clay land. In short, the beech is of a very accommodating nature in regard to soil, and we have no doubt it is from this that we see at the present day so many old beech-trees about the seats of proprietors both in England and Scotland. As to situation, although the beech may be said to be one of the hardiest of our forest-trees,

still it does not develop itself to anything like large dimensions unless it is planted on a rather low-lying and sheltered part of the country.

677. *Propagation and culture.*—The beech is propagated from the seeds, or *nuts*, which are well known: these are gathered when they fall from the trees in the months of October and November. Some nurserymen sow the nuts immediately in beds when they are gathered; but in our opinion this is not a good plan, for when sown in the month of November, and lying in the earth all winter, the seeds are exposed to the attacks of mice and other vermin, which thin them very much, and of course cause a great deal of extra trouble in preserving them unhurt. Our method is, to mix the seed, when gathered, with a quantity of dry sand, previously prepared, and allow it to lie in that state till the month of March, when it may be sown upon a light soil, and covered with about three-fourths of an inch of earth, and in this state the seeds will vegetate quickly. We may mention that we always sow in rows and never in beds, as when in beds the plants become so much crowded as to injure each other before they are ready for removal; whereas in rows they have always room on either side, and so become strong and healthy before the time of removal. The plants require to remain two years in the seedling state before being transplanted out into the nursery-rows, which may be done any time from November to March when the weather is open. The distance between the rows in the nursery may be about 18 inches, and the plants may be put in about 4 inches one from another. When the plants have stood two years in the nursery-rows, they will answer well for all purposes. While the beech is in the nursery no pruning of the branches should be allowed, as the plant does not stand cutting well in its young stages. Indeed, no pruning should be performed on the beech till the plants have become well established in their permanent sites. We make this remark as we have often seen the beech very much injured by pruning when it was removed from the nursery and planted out in the open ground.

678. The beech attains a large size on suitable soils. On the chalk districts of England there are many beech-trees of very large dimensions, especially on the parks of landed proprietors—some of them measuring upwards of 110 feet in height, with stems from 4 to 6 feet in diameter at 5 feet from the ground. On many places in Scotland there are also fine specimens of the beech, some measuring from 80 to 100 feet high, with stems equal in diameter to most of those found in England.

SECTION VI.—THE MAPLE (ACER)—LINNÆAN SYSTEM, POLYGAMIA MONŒCIA.

679. *Character of genus.*—Flowers monœcious. Hermaphrodite—calyx 5-fid.; corolla 5 petals; stamens 8; styles 2; samara winged at end, 1-seeded. Male—calyx 5-fid.; corolla 5 petals; stamens 8.

680. There are many species of maple, but the only ones we think it worthy to attend to in a work of this kind are—1st, the great maple or sycamore; 2d, the Norway maple; and 3d, the sugar maple of America. We shall begin our description with the first named.

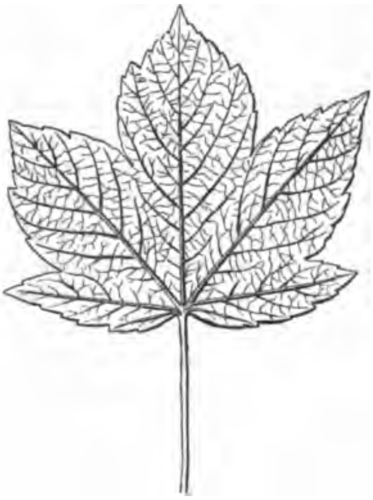
ACER PSEUDO-PLATANUS, Sycamore or Great Maple.

681. *Specific character.*—Leaves cordate, 5-lobed, glaucous and smooth beneath; lobes unequally toothed; racemes pendulous; fruit smooth.

682. *Geography.*—The sycamore is found indigenous to various parts of Europe—Switzerland, Germany, and Italy especially; and is found chiefly on the hilly parts of these countries. Whether it is really a native of Britain is doubtful; but be this as it may, it is as hardy as any other tree we have—and indeed is as well fitted to our climate as the ash or the elm.

683. *Description of tree.*—The sycamore is very easily distinguished by its beautiful 5-lobed leaves; or, as botanists describe them, *heart-shaped*, with 5 acuminate, unequally-toothed lobes (see fig. 83).

Fig. 83.



It is a tree of first-rate magnitude, and lives to a great age. It is of rapid growth; and from its leaves being large, it always presents a heavy mass of foliage as compared with most other trees. From the latter feature in the appearance of the tree, many consider it of a heavy and gloomy aspect, and not fit to be introduced into particular parts of landscape,—especially, they say, where a lively natural effect is desired. Our opinion, however, is quite the opposite of this. Only let the fine effect that this tree has upon our lawns and parks about the end of April and beginning of May be considered: it is then that the sycamore appears to best advantage; its light-green leaves have then a freshness and a lightness indescribable, and give the park upon which the trees stand quite an oriental appearance. The very circumstance of the sycamore coming into leaf earlier than almost any other tree upon the lawn, makes it a favourite with the lovers of natural scenery; and even in the midst of summer the tree presents a grand unbroken mass of foliage, which contrasts pleasantly with other trees of a more airy character, particularly if the situation be a prominent one. The sycamore is not a tree that carries height along with its girth compared with many other forest-trees; and this is particularly the case when it is found growing free in an open park or lawn. In such a situation it forms a rather short massive stem, with a spreading head of frequently very great magnitude.

684. *Economic uses of timber.*—The sycamore, when of large dimensions, is a very valuable tree, often being sold at rates varying from 2s. to 3s. per cubic foot. The timber is reckoned of excellent quality, and when well matured and of large dimensions it is sure to sell at a good price, but when of small sizes it is not reckoned of much value. There is not a large quantity of sycamore timber of large dimensions brought into the market, and when a few good trees are offered for sale they always bring a high price. Sycamore wood enters largely into the manufacture of household furniture, wooden dishes, and certain parts of fixed rural machinery; and a considerable quantity of it is used by turners and toy-makers. It is also much used in the making of ends for herring-barrels, and for this purpose large quantities of the smaller-sized timber are used.

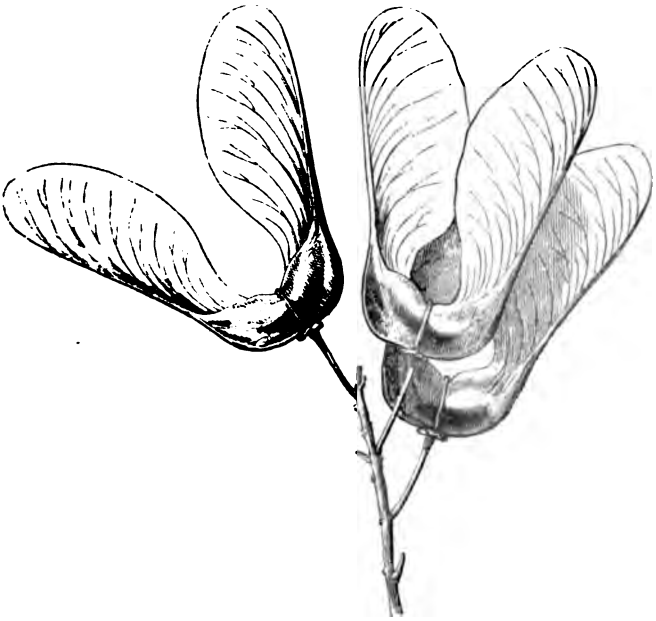
685. *Soil and situation.*—Few of our forest-trees succeed on a greater variety of soils and situations than the sycamore. It is, without doubt, one of the most accommodating trees we cultivate, as we find fair specimens of it on all kinds of land, from stiff clay to light sand; and on all kinds of situations, from much-sheltered to much-exposed, and from low-lying to high-lying. In no case, however, do we find it in health and of fair dimensions of timber on a wet soil. It must be on land free from stagnant water, or if not, it will become stunted, and die at an early stage.

The circumstances which are found most favourable to the healthy development of the sycamore are—as to soil, dry sandy loam, porous and open in the subsoil, with a free exposed situation, as in the open parks about gentlemen's home-grounds.

The sycamore, from its being easily checked in the side branches, is well adapted as a nurse for other more valuable trees in a forest. It also makes an excellent coppice-wood, the young shoots growing exceedingly rapidly from the stock, and making from 3 to 5 feet of length in one season. Being an exceedingly hardy tree, and of a peculiarly stiff and unbending habit, it is well adapted for hedgerow timber; and, moreover, being a tree which comes very early into leaf in the spring, it has the advantage of producing considerable shelter to the fields by its large leaves, as well as giving a healthy and clothed appearance to the country. Many, indeed, object to it as a tree adapted for hedgerow timber, upon account of its widespreading branches; and no doubt it must be confessed that these will, under careless management, cast a great shade upon the land on each side of the hedgerow; but if it be properly trained by judicious and early pruning, it may be made not a widespreading tree, but a tall closely-branched one, of the best description possible for producing shelter to the adjoining fields. (See chapter upon Hedgerow Timber.)

686. *Propagation and culture.*—The sycamore is propagated entirely by seeds, excepting, indeed, the variegated and other varieties, which are increased by budding or grafting. When the seeds are ripe (see fig. 84), they should be sown immediately after being gathered, because they are extremely apt to lose their vegetative powers. This may be done about the middle of October; or if it should be preferred to keep the seed till spring, it should be mixed

Fig. 84.



up with a quantity of dry sand, and sown as early as possible in the spring. When the seedlings are one year old, they should be planted out into the nursery-rows, where they should remain two years, before being removed to the forest-ground. For the distance at which the plants should stand in the nursery-rows, see that already given for the ash. In its young stages the sycamore-tree is very apt to throw out very strong side-branches; and in its cultivation in the forest, therefore, it should be attended to by judicious pruning. In regard to such pruning, we must remark, however, that if the young trees be cut and pruned in the winter or spring months, they are sure to bleed profusely at the wounded parts, and will very probably remain stunted for a year or two afterwards; therefore, when it is found necessary to prune the sycamore, let that be done in the summer months, or in the growing season of the tree, when, instead of being injurious, judicious pruning becomes beneficial to it, because the sap at this season is quickly formed into proper woody matter, and the wound heals up in a very short time, causing the stem to become strong and healthy by having the sap directed towards it.

687. There are many fine specimens of the sycamore both in England and Scotland, some of them from 70 to 100 feet high, with stems varying from 6 to 8 feet diameter.

ACER PLATANOIDES, or Norway Maple.

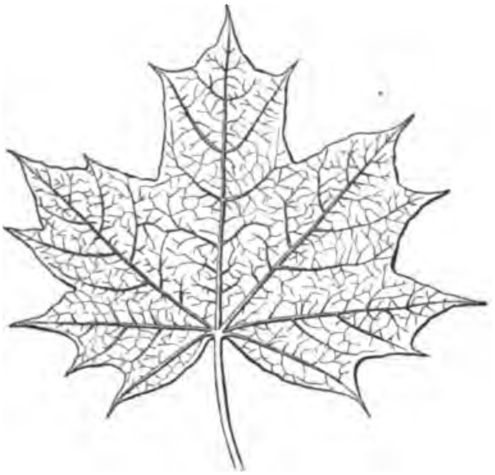
688. *Specific character.*—Leaves cordate, 5-lobed, smooth. Lobes acuminate, cuspidate, somewhat toothed. Corymbs nearly erect.

689. *Geography.*—The Norway maple, as its name indicates, is a native of Norway; but besides being indigenous to that part, it is found also in Germany, in Switzerland, and France, and from the last-named country eastward to the eastern boundary of European Russia; and is quite common in all the woods of Russia. It is one of the most hardy trees that has been introduced into Britain, and is well deserving a place in our plantations, both in respect to the value of its timber and its ornamental effect.

690. *Description of tree.*—The Norway maple is a tree of first-rate magnitude, attaining nearly equal dimensions with the sycamore in a given period, and is by far too little cultivated in Britain. As a lawn tree, it is perhaps not surpassed by any other. A particular recommendation of it is, that it comes early into leaf; and in the autumn the leaves of this tree give an extremely rich and varied effect, from their bright yellow colour contrasting with the dark-green and russet tints of the other trees. The form of the tree, although much resembling that of the sycamore, is more open and

light, and it does not form so heavy nor so massive an appearance, being easily distinguished at a distance by an outline more natural, easy, and light than the sycamore. The leaves somewhat resemble those of the sycamore, but are more acute in the angles (see fig. 85). They are also fully as large as those of the sycamore, but of a lighter green, and more transparent in the texture; and a particular character of the leaves is, that they are never apt to be eaten or injured by insects, as is the case with most other trees; hence they always present a sound healthy appearance. The young shoots of this tree are at first of a greenish colour; but as the season advances, and the wood becomes more ripened, they become of a brown colour, with white spots upon the surface of the bark. In the winter season this tree is easily distinguished from the sycamore by the bark upon the old wood or body of the tree, which is of a brownish-grey colour, the buds being of a deep red, very prominent and large.

Fig. 85.



691. *Economic uses.*—We have not had many opportunities of seeing the wood of the Norway maple cut up for use, it being by no means plentiful enough in Britain to be used for common purposes, as is the case with the sycamore; but from specimens of the trees that we have seen felled, and manufactured into articles of various kinds, it appears to us to be a wood in all respects equal to that of the sycamore; indeed, the grain of the wood seems more close than that of the latter, as it takes on a better polish. We have now seen it used for many of the purposes to which the wood of the sycamore is applied, and have no doubt it may be applied to all the purposes that sort is generally used for.

692. *Soil and situation.*—The soil most favourable for the growth of this tree is found to be a free, open, sandy loam; but although under such circumstances it does no doubt grow most rapidly, and develop itself to greatest advantage, it will nevertheless grow freely upon very inferior soils, provided that such be dry and properly drained.

Being a native of the colder regions of Europe, the Norway maple is well adapted, as a useful timber-tree, for British plantations. It is found growing in Norway down to the very sea-shore, and is there found to stand the blasts of the sea excellently—so much so as to become timber of considerable dimensions: it is therefore remarkable that it has not been more cultivated in this country, particularly upon estates along our sea-coasts. Upon the west coast of Scotland we have seen it thrive well; and from specimens that we have seen growing there, especially on places on the shores of Galloway, we are convinced that, were its cultivation extensively put in practice, the Norway maple would there supersede most other trees; and instead of that barrenness of appearance which so generally characterises the west coast of Scotland, a beautiful woodland aspect might be given to the greater part of it, were this valuable tree introduced there as its merits demand.

693. *Propagation and culture.*—The Norway maple is propagated by seeds in the same manner as the sycamore, and in every respect the method of culture stated for the sycamore is applicable to this tree; and we may add further, that it bears seed at a very early period. We have frequently gathered good seed from trees of thirty-five to forty years' growth, and this in the end of September and the beginning of October.

694. There are some fair specimens of the Norway maple on the island of Bute. Several of them are upwards of 70 feet high, with stems from 2½ to 3 feet diameter. There are some good specimens of this tree at various places in England, and especially at Kew and Sion House.

ACER SACCHARINUM, or Sugar Maple.

695. *Specific character.*—Leaves subcordate, acutely 5-lobed, downy beneath; lobes nearly entire; corymbs before the leaves; loose, nodding.

This tree is easily known from the Norway maple by the leaves being whitish on the underside in summer, and by their becoming reddish early in the autumn, instead of yellowish, as those of the Norway maple do. The bark of the sugar maple is of a whitish colour, while that of the Norway maple is of a light brown, and from these characteristics the trees may be easily distinguished.

696. *Geography.*—We have found this tree plentifully all over Upper Canada, on most of the richer parts of the lands forming nearly the third part of the natural forests there. In Lower Canada it is plentiful; also on the better parts of the country, but not nearly so much so as in Upper Canada, where the soil is generally of a deeper and richer character than in the lower province. We have found it also in many parts of the Northern States of the Union,

especially in New York and Pennsylvania; but as the greater portion of the natural forests is now cleared there, it is only found in patches that remain, indicating that the tree had formed a large part of the crop of the natural woods there, as it now does in those of Canada.

697. *Description of tree.*—At first sight the leaves of the sugar maple very much resemble those of the Norway maple, as they are nearly of the same shape and general size; but on a closer examination of the two kinds, and especially on comparing the under sides of the leaves, it is found that those of the sugar maple are whitish, while those of the Norway maple are not. In the American woods, even under ordinary circumstances of soil, the sugar maple becomes a large and handsome tree, seldom under 90 feet in height, and generally having stems of from 2 to 4 feet diameter. We have ourselves very often seen trees of this kind with stems fully 5 feet diameter, clear of branches to a height of 60 or 70 feet, while they stood over 120 feet high. It is this tree that gives the well-known splendid effect to the American woods in the months of September and October. Then the leaves put on all shades of colouring from a bright orange to a dark crimson; and these, mixed with the still green leaves of many other trees, give an effect to the woodland scenery of America which is not seen in any other part of the world. The splendour produced by this colouring of the leaves of the sugar maple is greatly heightened by the trees being backed by the dark foliage of the pine; and it is where these two kinds are found growing together that the grandest effect is produced. The tree is, in an ornamental point of view, well worthy of extensive cultivation in Britain. Those who have not seen this tree in its native habitats in autumn can form but a very imperfect idea of the beauty it gives to woodland scenery. Let proprietors plant it along the margins of their woods, along the sides of roads and walks running through their plantations, and on prominent sites here and there over their estates, and the pleasure of the effect they will produce in the autumn by the various colourings of their leaves will amply repay them for their trouble. In planting the sugar maple, in order to insure its giving the best effect, it should be planted with an intermixture of trees of a dark-coloured and evergreen foliage, as these, properly mixed, will produce a colouring of foliage in the autumn that will baffle description, and produce a picture which no painter's art can imitate.

698. *Economic uses.*—In America there are few trees applied to more general use than the sugar maple. Where it is plentiful, the timber is used as fuel in preference to any other kind. In house-building it is much used, and in furniture it is used very extensively,

making perhaps the most beautiful of all household furniture, that called "bird's-eye maple." Considerable quantities are brought from Canada to Britain for the purpose of cabinetmaking. That the sap of this tree produces large quantities of sugar is perhaps not necessary to be referred to here.

699. *Soil and situation.*—This tree is not so hardy in the climate of Britain as the Norway maple or the common sycamore, but in all cases requires a rather sheltered situation, and a dry, open-bottomed, rich, and rather light soil, to succeed well on. It will thrive well and attain respectable tree dimensions on parts of the country not over 400 feet above sea-level, when it has the shelter of other plantations, and when planted on the southern sides, and in openings in these; but it will not grow on bleak or exposed parts, nor on a cold-bottomed land, especially if it have a northern exposure.

700. *Propagation and culture.*—This tree in Britain is raised from seeds imported from America, and in the culture of the plants they are dealt with in the nursery in all respects as has been recommended for the cultivation of the sycamore. Young plants are, however, often imported from America.

SECTION VII.—THE PLANE-TREE (PLATANUS)—LINNÆAN SYSTEM, MONŒCIA POLYANDRIA.

701. *Character of genus.*—Male, a globose catkin; calyx, none; corolla, scarcely any; anthers growing about the filament; female, a globose catkin; calyx, many-leaved; corolla, none; styles with a recurved stigma; seeds roundish, mucronate, with the style pappose at base.

We shall refer only to two species of the genus, as they are the best known, and at the same time the most ornamental—viz., the Oriental plane-tree, *P. orientalis;* and the American one, *P. occidentalis.*

PLATANUS ORIENTALIS, or Oriental Plane-Tree.

702. *Specific character.*—Leaves 5-lobed, palmate, cuneate at base; segments lanceolate, sinuated; stipules nearly entire.

703. *Geography.*—The Oriental plane-tree is a native of the Levant, Asia Minor, and Persia, and seems to have been cultivated in Britain as an ornamental tree for the last 300 years. It is said to be found on Mount Etna at an elevation of 2000 feet above the sea-level; but it seldom attains its full dimensions as a timber tree except in low-lying and level parts of the country, on a light deep soil, in the neighbourhood of running water.

704. *Description of tree.*—The Oriental plane is said to be one of

the noblest trees of the East, where it grows to a height of 70 and 80 feet, with widely-spreading branches and a massive trunk, forming altogether a majestic tree. As an ornamental tree, no one which attains so large a size has a finer appearance, standing singly or in small groups upon a lawn where there is room to allow its lower branches, which stretch themselves horizontally to a considerable distance, to bend gracefully towards the ground, and turn up at their extremities. The tree is in all respects peculiarly adapted for pleasure-grounds, and for growing in town gardens, as it seems to be very little affected by their smoke. This tree thrives well in Britain, and attains very considerable dimensions, where sheltered by other trees, on parks and lawns. It is easily distinguished from the maples—which have leaves somewhat similarly shaped—in the winter season, by its bark scaling off; and in the summer season, by its leaves having stipules. Fig. 86 represents a twig of the *P. orientalis* with its leaves and stipules.

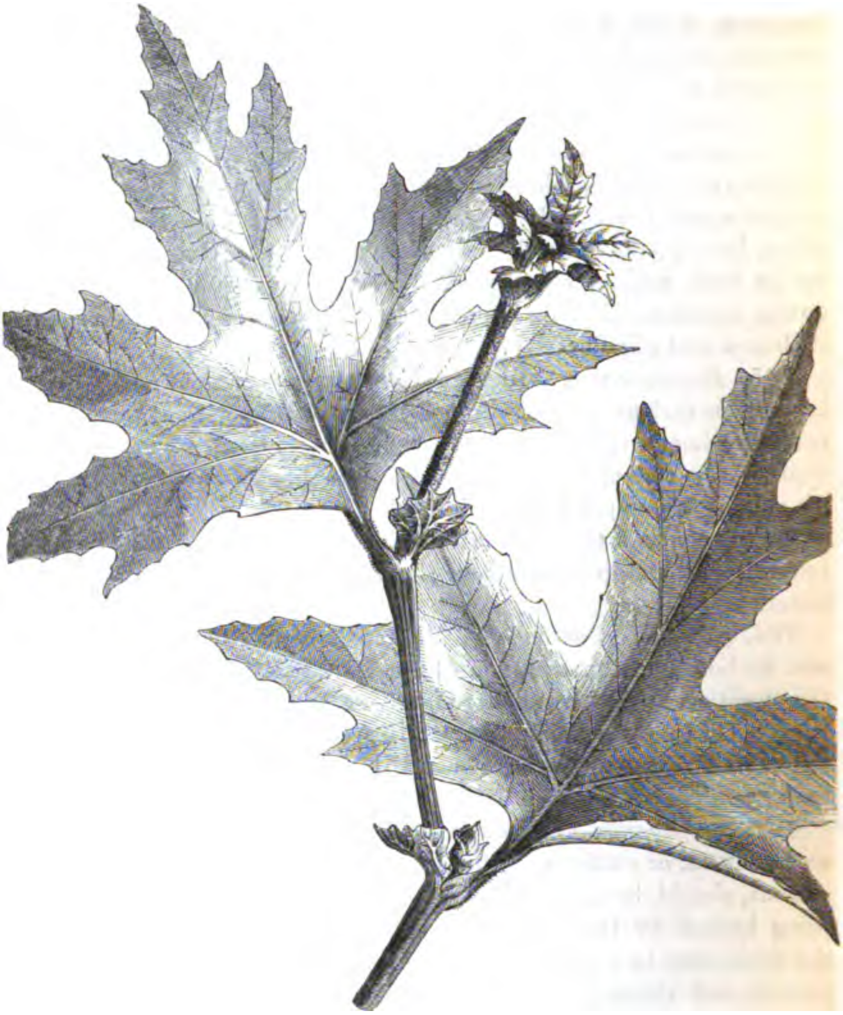
705. *Economic uses.*—In the native countries of this tree its timber is used for various purposes in furniture-making and carpentry. From some specimens of trees that we have ourselves seen cut up in this country, the timber seems of as good a quality as our sycamore, and we should say, might be used in all cases in which it is used. It is not, however, as a timber tree that it is cultivated in this country, but only as an ornamental one; and in this respect few trees are better.

706. *Soil and situation.*—A light, deep, free soil, moist, but not wet at bottom, is that on which the *P. orientalis* thrives best; and the situation should be sheltered, but, at the same time, not shaded or crowded by other trees. It will scarcely grow in strong clay and on elevated exposed parts; nor will it thrive in places where the lime-tree does not prosper.

707. *Propagation and culture.*—This tree may be propagated by seeds, layers, or cuttings. The seeds, which ripen in Britain in fine seasons, should be gathered in October or November; and the balls being broken by the hand or by thrashing them with a light flail, the seeds may be separated from the husks and cleaned by the usual process, and either sown immediately, or mixed with sand and preserved in a place secure from frost till February or March. The seeds may also be kept in the balls or catkins till spring, either by allowing them to hang on the tree, or by gathering them in autumn and spreading them out in a dry loft. The general practice is to sow the seeds in autumn, or as soon as gathered or received from the Continent, choosing a moist rich soil and a shady situation, and covering them as lightly as those of the birch or alder are covered, or beating them in with the back of the spade, and not covering

them at all,—protecting the beds with litter of some sort to exclude the frost. The plants will come up the following spring. The tree is commonly propagated by layers, however, which root freely.

Fig. 86.



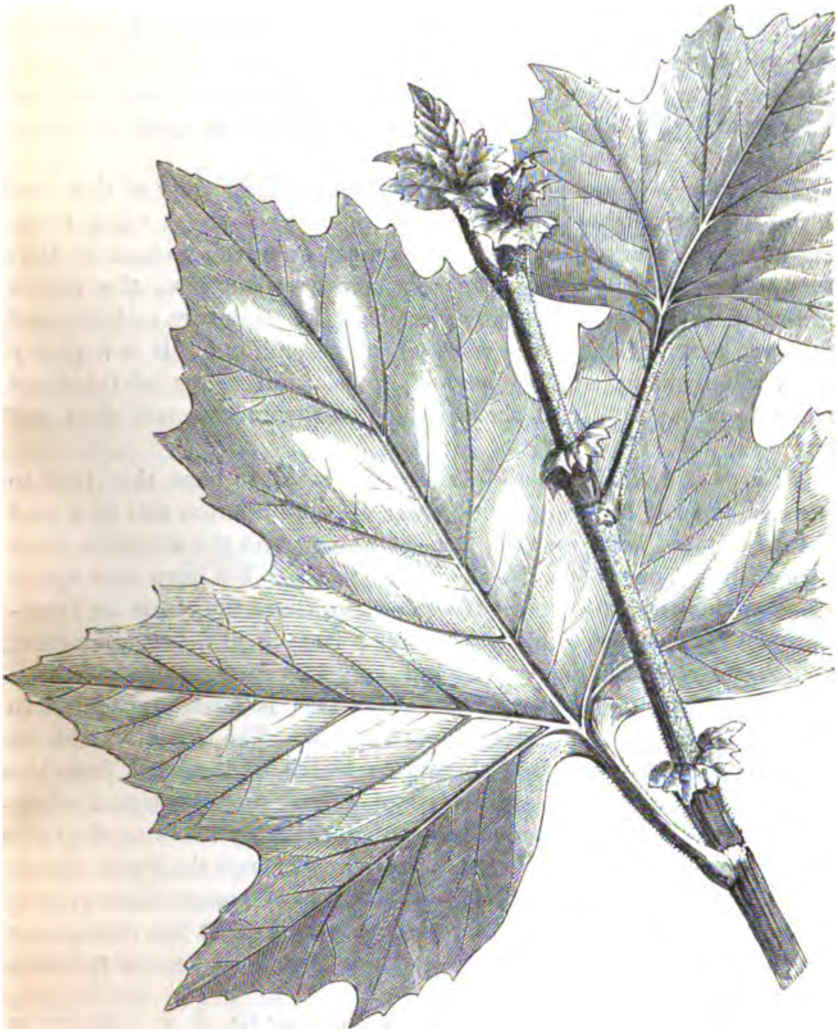
708. There are many good specimens of the Oriental plane found at various places in both England and Scotland, some of them rising to heights from 60 to 80 feet, with stems from 3 to 6 feet diameter.

PLATANUS OCCIDENTALIS, or American Plane-Tree.

709. *Specific character.*—Leaves 5-angular, obsoletely lobed, toothed, cuneate at base, downy beneath.

710. *Geography.*—The American plane is found over a large extent of the North American continent, from the eastern seaboard to the Western States, and from the southern parts of Canada southwards to the Carolinas. We have found it plentiful on the sides of rivers in the State of Pennsylvania, and also on the Grand River in Canada; but we have never found it on dry parts inland from rivers.

Fig. 87.



711. *Description of tree.*—This species is of much more rapid and upright growth than the Oriental plane, already referred to, and has broader and less deeply cut leaves (see fig. 87). The American plane may be readily distinguished from the Oriental by the leaves of the

former having red petioles, and fruit comparatively smooth and considerably larger. The *P. occidentalis* is also readily distinguished from the *P. orientalis* by its more upright habit and rapid growth, especially when placed on a low-lying level part, near to running water. Having seen this species in its native soil and climate, we are prepared to state that it is not of so ornamental a habit as the *P. orientalis*. Its outline in all its stages is more stiff, and therefore less graceful, than that of the other. But even making full allowance for this, it is a handsome tree, and well worthy of a place in any well-sheltered park on a site by a river side. There its generally tall form and beautifully waving masses of leaves give it a character peculiar to itself, and which is found to give quite a foreign expression to the scene.

712. *Economic uses of timber.*—In America the timber of this tree is not held in much estimation; and we have observed, when making inquiries in regard to this point among American tradesmen, that they never use it for any purpose when they can have the maple instead. It is sometimes, however, used for furniture-making, and for some parts of the inner work of house-building. It is a pretty wood when cut up, and we have seen beautiful pieces of furniture made from it; but it is short-grained, easily broken, and does not last well.

713. *Soil and situation.*—As already stated, to have this tree to succeed, it must be planted on a deep, open, and porous soil of a cool nature, but not wet, as on the sides of rivers; and the situation must be a sheltered one, otherwise it will not thrive. We have seen specimens of this tree growing on the sides of some of the rivers in Pennsylvania fully 100 feet high, with stems from 3 to 6 feet diameter; and these grew on a deep sandy soil, very rich in vegetable matter.

714. *Propagation and culture.*—This tree is often propagated in Britain from seeds imported from America. The seeds should be sown in a cold frame in February or March, and shaded from the sun till the plants have come up and gained some strength: afterwards they should be gradually exposed till they are inured to the sunshine; and after they have become hardy enough the frame should be removed, and the plants left to themselves to mature their growth in the natural climate. Next season they will be fit for transplanting out into lines in the nursery, and this should be done as specified for the sycamore.

This tree is propagated also by cuttings, which root quite freely and form excellent plants, being as easily propagated in this way as the poplar. It may also be propagated by layers, and by this mode a large proportion of the plants reared in Britain are propagated.

715. There are many fair specimens of this species in most of the

parks in the neighbourhood of London; and on many places in England there are specimens even of larger dimensions than those of the *P. orientalis.* In Scotland also there are many good specimens of this species.

SECTION VIII.—THE POPLAR (POPULUS)—LINNÆAN SYSTEM, DIŒCIA OCTANDRIA.

716. *Character of genus.*—Barren flower,—scales of the catkin lacerated; anthers, 8 to 30, arising from a turbinate, oblique, entire, single perianth; fertile flower,—scales of the catkin lacerated; perianth turbinate, entire; stigmas 4; capsule superior, 2-celled, 2-valved, many-seeded; seeds comose.

717. There are several species of this genus which are well adapted for forest timber-trees. The sorts which are most worthy of our notice here are the black poplar, *Populus nigra;* the abele-tree, or white poplar, *Populus alba;* the grey poplar, *P. canescens;* the Lombardy poplar, *P. dilatata;* the black Italian poplar, *P. monilifera;* the Ontario poplar, *P. macrophylla;* and we may also add the aspen poplar, *P. tremula.* With the exception of the last named, these are all rapid-growing trees when found in a soil congenial to their nature, and attain very large dimensions. We shall begin our description with the first-mentioned—viz.:

POPULUS NIGRA, or the common Black Poplar.

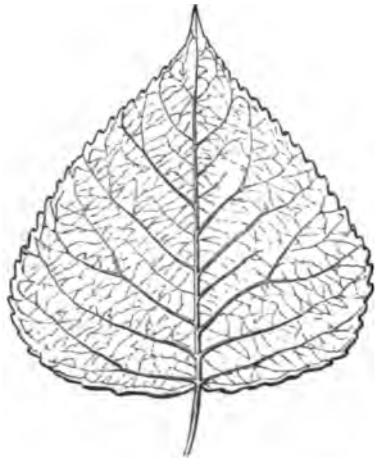
718. *Specific character.*—Leaves deltoid, acute, serrated, glabrous on both sides; fertile catkins, cylindrical, lax; stigmas 4.

719. *Geography.*—The black poplar is a native of Europe, from Sweden on the north to Italy on the south, and is most generally found occupying such parts of woodlands as are on moist land. It is said to be found also in some parts of the north of Africa, and is also considered a native of the British Isles.

720. *Description of tree.*—The *P. nigra* is a tree which attains large dimensions of timber in a very short time, but does not endure long when it has arrived at maturity, which may be reckoned at fifty years of age. When planted in a low-lying situation, where it has the advantage of shelter, it forms a very prominent tree in the landscape; but if planted among trees of a slow growth it soon overtops all others, and has by no means a fine effect; but when it is planted in a situation adapted to its rapid growth, it forms a magnificent tree, having a large spreading top, with an extremely massive trunk. The rapidity of the growth of this tree is very remarkable: for example, we have seen it, when only thirty years planted, 78 feet high, and

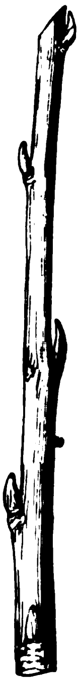
containing upwards of 60 cubic feet of timber, which proves the profitableness of the tree when planted on a proper soil and site. Many of the poplars much resemble one another in the appearance of their leaves, but the black is easily distinguished from the others by having its leaves of a pale-green shining colour; their shape is termed by botanists *deltoid*, or trowel-shaped, pointed and *serrated*, and smooth on both sides (see fig. 88). The leaf-stalks of this sort are thin and slender at their insertion upon the leaf, which gives them a vibrating motion upon the tree from every breath of wind.

Fig. 88.



721. *Economic uses of timber.*—The wood of this tree is much sought after by cartwrights for bottoming, and is also used for many purposes in turnery. It is also much used on the Continent, and in some parts of England as well, for wooden shoes.

Fig. 89.



722. *Soil and situation.*—In order to grow this species profitably, they should be planted in a good strong loam, rather of a moist and deep character, but not with stagnant water in the subsoil; for although the tree is a gross feeder, yet it will not—nor any of the genus—prosper if its roots get down into stagnant water. The best specimens we have seen of this tree grew upon a deep sandy loam, in a sheltered situation among other trees, where they had ample room to spread out their branches. We have, however, seen trees of very large size growing upon a poor light soil, situated upon a sloping bank where water percolated freely down the slope. But none of the poplars will succeed profitably upon a dry, thin, high-lying soil. All the poplars thrive well on the sides of rivers, where the land is well sheltered, and of a deep, open, and rather rich character; but even there they will not do well if the water stagnate about their roots.

723. *Propagation and culture.*—This species is generally propagated by cuttings of the young wood (see fig. 89), which are rooted in the nursery-ground with extremely little attention; and after remaining one year in the cutting state in the nursery, they are fit for transplanting out into the forest ground.

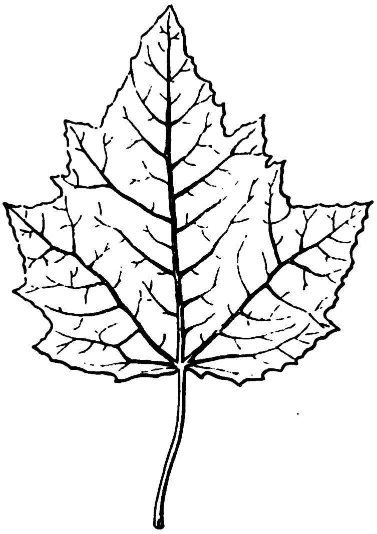
724. This species is plentiful on most alluvial parts of the country, often forming trees 80 feet high, with stems over 3 feet diameter.

POPULUS ALBA, the Abele-Tree or White Poplar.

725. *Specific character.*—Leaves roundish, cordate, lobed, toothed, glabrous above, downy and very white beneath; catkins of the female plant ovate; stigmas, 4.

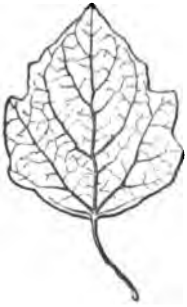
726. *Geography.*—The abele-tree is indigenous to many parts of Europe, and is found in the west of Asia and north of Africa. It is cultivated plentifully in Germany and France. In some of the forests of the latter country it is said to be so plentiful in some places as to form the prevailing tree over large districts, where it is the principal fuel of the inhabitants. This tree has been long in cultivation in Britain, and is considered as one of the indigenous trees.

Fig. 90.



727. *Description of tree.*—This is a tree of a well-formed upright habit, and upon a lawn or park it makes a very fine contrast by its white, waving, downy leaves and silvery branches glittering among others of a darker colour. The leaves of this species are upon young plants almost *palmate*, and larger than those taken from an older tree (see fig. 90, which shows them as taken from a coppice of the second year's growth). In the young state the leaves are covered with a white down beneath, and on the upper surface but slightly. Upon plants a few years old the leaves are much smaller, and also dark-green, and smooth on the upper surface, and not palmate, but merely lobed, and somewhat toothed (see fig. 91). The young branches are also thickly covered with down, and are of a more spreading and ramifying habit than those of the last-mentioned sort (see fig. 92), and also more slender and tough. This tree, wherever it is planted, sends up large quantities of suckers from the roots all round, which often become troublesome on pasture. Therefore, where clean pasture is an object, this tree should not be planted on it, but confined to the woodlands.

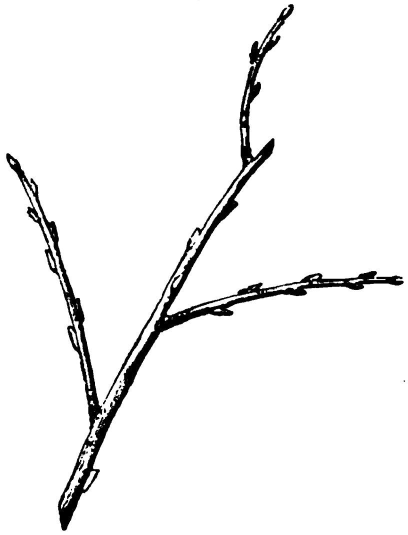
Fig. 91.



728. *Economic uses of timber.*—The wood of this species is white, very light and spongy, but is as durable as that of the former sort when cut up. We have ourselves cut up and sold considerable quan-

tities of it for planking, which is used for flooring, cart and waggon bottoms, &c., and it sells readily for these purposes. It is also used for packing-cases, for turnery and cabinet-work; and the boards and rollers round which silk is wrapped are for the most part made of it, from its being soft and light, and not liable to injure the cloth.

Fig. 92.



729. *Soil and situation.*—Like the *P. nigra*, this tree delights in a sheltered situation upon a moist loamy soil. We have planted it extensively on low-lying grounds on the sides of water streams, where the land was deep and open, and on these it grows rapidly, in a few years attaining large dimensions. On deep open land, and on sheltered situations, we find that, next to the black poplar, it is the most rapid-growing of the genus, and well worthy of extensive culture for many purposes. It is an excellent tree for coppice-wood, and produces, on low-lying and favourable sites, a crop very quickly. It thrives well in the neighbourhood of towns, and does not seem to be much affected by the smoke from them as some other trees are.

730. *Propagation and culture.*—The young plants of this species are propagated by cuttings, layers, and suckers, which rise freely from the roots wherever they are growing; and if put into the nursery-ground in the spring, they will be ready for transplanting out into the forest-ground in the autumn or spring following.

731. This species in favourable soils and sites forms a large timber-tree, attaining heights from 70 to 100 feet, with stems from 2½ to 5 feet in diameter.

Populus canescens, or the common Grey Poplar.

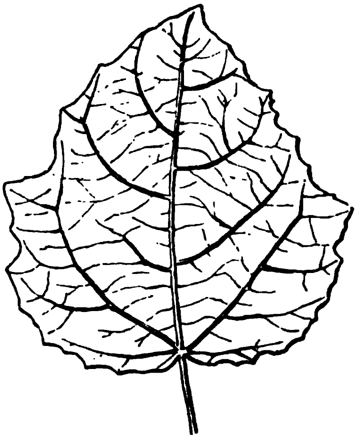
732. *Specific character.*—Leaves roundish, angular, repand, toothed, hoary beneath; catkins cylindrical, lax.

733. *Geography.*—The common grey poplar is generally believed to be a native of Britain, France, and Germany.

734. *Description of tree.*—The grey poplar very much resembles the last-mentioned species, but is easily distinguished from it by its greater propensity to send up suckers, and that at a great

distance from the tree, and also by the branches being more upright and compact. The leaves are rounder, more conspicuously 3-ribbed, and less deeply or acutely lobed; not folded in the bud, and without gum. They are downy beneath, but the down is chiefly greyish, and not so white or cottony as in *P. alba;* in some instances the leaves are glabrous. This species can at once be distinguished from the *P. alba* by its leaves being less deeply lobed, and the down being somewhat grey upon the under side of the leaf (see fig. 93). In favourable situations it grows as rapidly and to as great a size as the *P. alba,* but has its branches thrown out more uprightly than it; and, in our opinion, it forms a very ornamental tree in a low-lying situation upon a soil adapted to its nature. It is a very hardy and accommodating tree, and attains a timber size upon a greater variety of soils and situations than any other of the poplar tribe. This species also makes excellent coppice, and is very productive in young shoots, which rise up freely in a very indifferent soil, and might be made very profitable if cultivated to a large extent for poles, fencing, &c. &c. As a coppice it is very easily kept up, on account of the great tendency the tree has to throw up suckers all over the ground upon which it grows.

Fig. 93.



735. *Economic uses of timber.*—The wood of this tree is used for the same purposes as that of the *P. alba.* But we may add here, that the timber of both species, when of large size and good quality, is much sought after for musical-instrument making, and for carving purposes, and also for wooden dishes.

736. *Soil and situation.*—The soil on which this species attains its greatest bulk of available timber is a good loam near to a supply of running water: however, as already stated, it attains a timber size upon a greater range of soils and situations than any other of the poplar tribe. Still, it is only in a low-lying situation, and on a good, rather moist loam, that it develops itself perfectly,—under these circumstances becoming a very large spreading-topped tree, frequently rising to 80 feet high.

737. *Propagation and culture.*—The grey poplar is propagated in the same manner as the last-mentioned sort, but very seldom from cuttings, the suckers in all cases making the preferable trees,—therefore these are almost in all cases preferred for a supply of young

trees; and when they are lifted from the roots of the parent plant, and put into rows in the nursery-ground for one year, they will then be ready for transplanting out into the forest. As, however, a supply of plants from this source cannot always be had, nurserymen generally propagate them by layers from stocks cultivated for the purpose in their grounds, and in the same way as they do the English elm.

738. Generally speaking, the characteristic of this species is its heavy-branched and widespreading top, with a greater diameter of stem in proportion to its height than any of the other poplars. On many parts we find the stem of this tree upwards of 4 feet in diameter, while its height does not rise much over 60 feet. The tree is common on all parts of the country, there being few places without a few fair specimens of it.

POPULUS DILATATA, or Lombardy Poplar.

739. *Specific character.*—Leaves smooth on each side, acuminate, serrate, deltoid, broader than long.

740. *Geography.*—This tree, as its name indicates, is a native of Lombardy in Italy, and it is said to be found growing naturally on the banks of the Po. It was introduced into Britain about the year 1758.

741. *Description of tree.*—This species is easily distinguished from all other trees of the genus by its tall narrow form, and by the entire absence of horizontal branches. In this respect its habit very much resembles that of the Irish yew. It is not a tree suitable for the forest as a timber-bearing one. It is, however, excellently adapted to stand as an ornamental one on certain situations on a park among other sorts, as its tall and upright form has an imposing effect among trees of a lower and spreading habit.

742. *Economic uses of timber.*—From the stem of this species being generally deeply furrowed, and seldom attaining great diameter, it is not valuable as timber, but chiefly prized for ornamental effect. We frequently see trees of this sort, in England, not more than fifty years planted, that have attained the height of 100 feet. The timber is, however, when of large size, used for the same purposes as that of the kinds already referred to, but it is generally rejected when the timber of the black or white poplars can be had.

743. *Soil and situation.*—The Lombardy poplar requires a strong loamy soil to enable it to grow so rapidly as it is capable of doing, and at the same time a low-lying and naturally sheltered situation: without these it grows comparatively slowly, and becomes a tall, dense-branched bush. It is admirably adapted for planting in the streets of towns, as it takes up but little space with its closely-

drawn-up branches, and is very little affected by the smoke, in which many other kinds of trees would languish. When the trees are planted closely in a line, they form an excellent tall hedge in a remarkably short time, giving shelter to more tender plants for a considerable distance out from them.

744. *Propagation and culture.*—This tree is propagated chiefly by cuttings of the young wood, which in light open soil root freely, and are fit to plant out when one or two years old, according to the height of plants wanted.

POPULUS MONILIFERA, or Black Italian Poplar.

745. *Specific character.*—Leaves subcordate, smooth, glandular at base, serrate, cartilaginous, hooked, hairy; nerves spread; branchlets winged, simple.

746. *Geography.*—This tree is a native of Canada and the United States, where we have met with it growing naturally in ravines and on strong clay-lands, and there forming a tree of moderate size, but never to such dimensions of timber as it attains in Britain. In its native sites it is generally found growing along with other native species of the same genus, forming trees from 60 to 70 feet high, with stems from 18 to 24 inches diameter near the ground; while, in the cultivated state, in Europe it often attains heights of 100 feet, with stems between 3 and 5 feet diameter. When cultivated in the Western States, however, it attains very large dimensions of timber.

747. *Description of tree.*—This may be said to be the most rapid growing of all the poplars. In habit it very much resembles the common black poplar, only it is more upright, and does not throw out its branches so widely. In its younger stages this sort is easily known from the common black poplar by its growing more direct in the form of an upright stem, and by its branches being smaller as compared with the diameter of the stem.

748. *Economic uses of timber.*—The timber of this tree is very similar to that of the black poplar, and is used for the same purposes in all respects. Indeed, many consider the timber of this tree superior to all other species of the poplar. It is generally found of greater dimensions, and therefore applicable to a greater number of purposes, than any other of the poplars; but as to the durability and quality of the timber, we are of opinion that it is not superior in these respects to the black poplar. However, none of the tribe can compare with this tree in the great length of its stem for available timber.

749. *Soil and situation.*—The black Italian poplar, to grow it in perfection, requires a strong loamy soil and a sheltered situation.

When planted on an inferior soil, and on a site much exposed to winds, it is inferior to the *P. nigra*, both in regard to the quantity and quality of its crop. It is only, therefore, as a timber-tree suited to the best districts of the country, and on such we have seen it of extraordinary dimensions, although comparatively young.

750. *Propagation and culture.*—This poplar is in all cases propagated from cuttings of the young wood, which root freely in any moderately light land. This year we have the cuttings of one year's growth fully 4 feet high, and fit to plant out into the forest-land, thus showing the rapid growth the tree makes, even in its first stage from the cutting.

751. This species is common in most alluvial districts of the country, where it attains very large dimensions, often reaching heights from 100 to 130 feet, with stems from 3 to 5 feet diameter.

Populus macrophylla, or the Ontario Poplar.

752. *Specific character.*—Leaves cordate, ovate, large, somewhat entire, pale beneath.

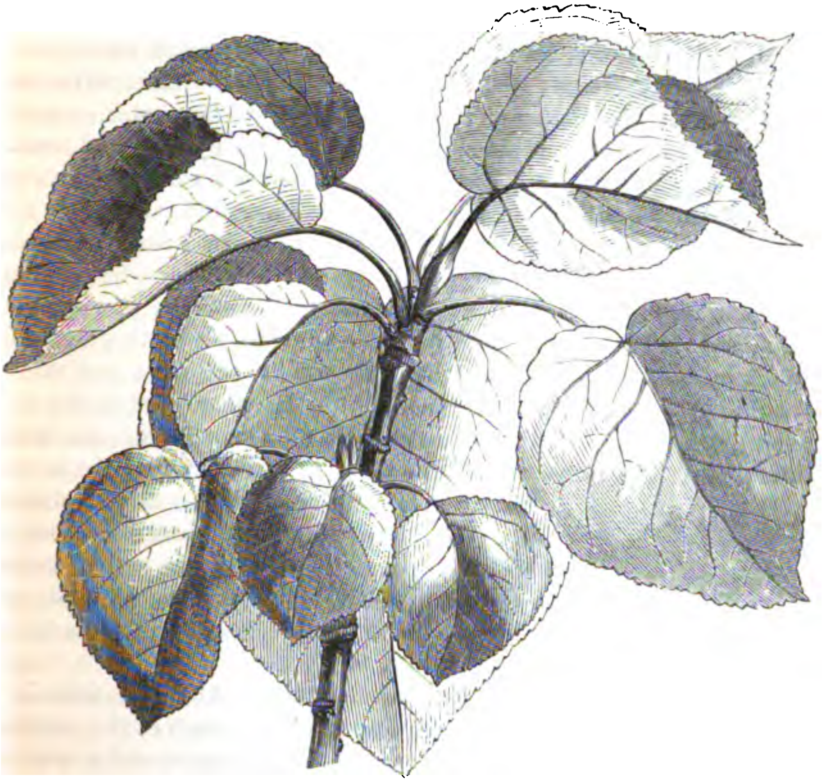
753. *Geography.*—This species is said to be a native of New Hampshire, United States of America, and to have been introduced into Britain in 1772. We never found it wild in America, although we have met with it often about farm-steadings, and in towns planted on the sides of the streets, but always in the cultivated state.

754. *Description of tree.*—This species is of an extremely rapid growth, and from this circumstance we think it well to describe it, and to state that in our opinion it is worthy of cultivation as a timber tree, especially on the sides of streams with a shallow soil, on which other sorts of trees would not succeed profitably. It is easily distinguished from all the other sorts of the same family by its very large heart-shaped leaves (see fig. 94), some of which measure 10 inches from base to apex: they are generally from 6 to 8 inches in length, and of a beautiful deep green on the upper surface. It may be also easily distinguished from any of the other poplars by its gummy buds, which, especially in the spring, have an agreeable balsamic smell. In this respect it resembles the common balsam poplar, but its leaves are so very much larger that the two are readily distinguished.

755. *Soil and situation.*—To grow the Ontario poplar well, it requires to have a plentiful supply of underground water, as without this it will not attain even respectable dimensions. It should be planted on lands only some 2 or 3 feet above the level of a river, and along its banks, as in such places it will attain large dimensions in a very short time.

756. *Propagation and culture.*—This species is readily propagated by cuttings, which make rapid growth during the first year, and are ready to plant out on the land they are to occupy when one or two years old, according as the plants may be wanted of a small or large size.

Fig. 94.



This poplar, when found in a suitable soil and site, attains a great height within a very short period. In some parts of the country it has been found to attain the height of 50 feet in fourteen years.

Populus tremula, Aspen or Trembling Poplar.

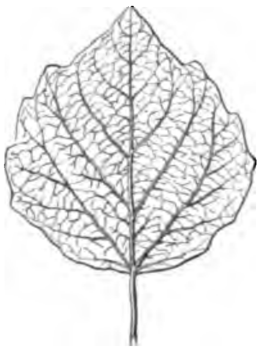
757. *Specific character.*—Leaves nearly orbicular, broadly-toothed, glabrous on both sides. Petioles compressed; stigmas 4, auricled at base.

758. *Geography.*—The trembling poplar is a native of most parts of Britain, and especially in the wet cold districts of the Highlands of Scotland. It is very plentiful in the valley of the Spey, and also

in that of the Dee as far up as Braemar. It is also found in Ireland. It is said to be met with, besides, in the south of Europe and in Asia, and even as far north as Lapland. In Russia it is found very plentifully in the woods.

759. *Description of tree.*—The aspen is a very interesting species of the poplar family, on account of its leaves being put into motion by the slightest breeze; and, indeed, few objects are more attractive in nature than the motion of the trembling poplar in a calm evening. The leaves of all the poplars are easily agitated by the most gentle breeze, but those of this one often become agitated while there is no breeze whatever to be felt; and it is this circumstance that gives the tree an interest to most people who witness it in a calm summer evening. It is a rapid-growing tree in its first stages, but seldom attains a large size of timber. The trunk is generally straight and clean, and tall in proportion to its diameter, with a smooth grey bark. The branches extend horizontally, and are for the most part thinly distributed on the stem, and become of a drooping habit as the tree attains age. This tree throws up suckers all round it from the roots, and we have often seen these grow up so plentifully round the parent tree as to form an impenetrable thicket around it. The leaves very much resemble those of the grey poplar; but they are easily distinguished from them by being more round, and also smooth on both sides, after the month of June (see fig. 95).

Fig. 95.



760. *Economic uses.*—Although this is a very interesting tree on account of the peculiar trembling motion of its leaves, and is worthy of a place in a properly-chosen part of a park or plantation, yet, as a timber tree, it is only of third-rate importance, and does not produce timber of nearly so good a quality as the other species already described. The wood, when cut up, is in all cases short-grained, and very easily broken when applied to any useful country purpose.

761. *Soil and situation.*—This species thrives on any moderate soil, provided it is rather of a wet nature than dry. The natural conditions of soil and site for this tree are found in most woods, such as prevail in many parts of the Highlands of Scotland. On low-lying meadows, however, on the edges of plantations, where the tree had a good depth of soil, of a moist nature, and at the same time was well sheltered by the adjoining plantation, we have found the largest specimens, some containing as much as 40 cubic feet of timber.

762. *Propagation and culture.*—This tree is propagated chiefly

from layers and suckers, the latter being found plentifully in every wood where the tree abounds. These have only to be dug up with their roots, and transplanted into rows in the nursery for a year or two, when they are fit for removing to where they are to be planted permanently.

763. This species, under the most favourable circumstances, seldom attains so large dimensions as the others named and referred to. Its general dimensions, under ordinary circumstances, may be said to be from 40 to 50 feet high, with a stem about 14 inches diameter. Under very favourable soil and site, however, it has attained the height of 70 and even 80 feet, with a stem about 3 feet in diameter.

SECTION IX.—THE WILLOW (SALIX)—LINNÆAN SYSTEM, DIŒCIA DIANDRIA.

764. *Character of genus.*—Barren flower,—scales of the catkin single-flowered, imbricated, with a nectariferous gland at its base; perianth, none; stamens 1-5. Fertile flower,—scales of the catkin single-flowered; perianth, none; stigmas 2, often cleft; capsule 1-celled, 2-valved, many-seeded; seeds comose.

765. There are many species of the willow family, most of them not growing to a size yielding useful timber: we shall therefore at present confine our description to those sorts which are, properly speaking, forest trees. Of these there are three deserving our attention—namely, the *Salix alba,* or common White Willow; the *Salix Russelliana,* or Bedford Willow; and the *Salix fragilis,* or Cracking Willow. All these, on favourable soils and sites, attain the size of timber trees of first-rate magnitude, and are well deserving of a place either upon a lawn or in a forest where profit may be the object. We begin our description with the first named, viz.:—

SALIX ALBA, or Common White Willow.

766. *Specific character.*—Leaves elliptic-lanceolate, acute, serrated, permanently silky on both sides; the lowest serratures glandular, stamens hairy, stigmas deeply cloven.

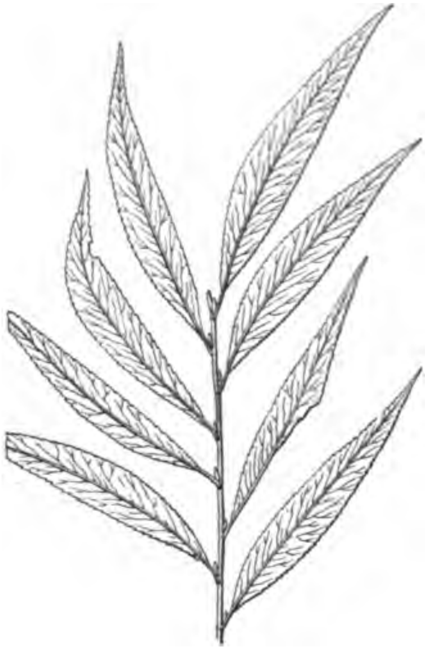
767. *Geography.*—This species is considered a native of Britain, and is found plentiful in most parts of Europe, from Sweden southwards to the Mediterranean, and is said to be found in Asia as well.

768. *Description of tree.*—The *Salix alba,* in a situation congenial to its nature, attains the dimensions of a first-rate tree, with an outline as agreeable and as elegant as can be imagined; and it is a tree well worthy of a place in any extensive park or lawn, where the soil is deep, strong, and somewhat moist, and the situation not too much

exposed. Its growth is very rapid, and it is thus well adapted to plant in any situation upon a park where it may be wished to hide any disagreeable object.

The leaves of the different sorts of willows have a close resemblance to one another, and indeed can only be detected and distinguished by a careful examination of their texture, more than any difference of shape. The white willow has the leaves *elliptic-lanceolate*, or between oval and lance-shaped, and serrated, the lower serratures bearing small *glands*. Both sides of the leaves are covered with very fine silky hairs, which lie close upon the body of the leaf, giving the leaves a whitish appearance, and causing a beautiful effect when they are slightly moved by the wind. Fig. 96 is an exact representation of the leaves and young wood, as taken from a plant in the month of August. We need scarcely say that this willow makes one of the best of all trees for the purpose of coppice-wood, and forms a very profitable crop when cut over at periods of from three to twelve years for poles of various sizes.

Fig. 96.



769. *Economic uses of timber.*—The wood of all the tree willows is much sought after, and preferred in all cases to that of the poplar. It is reckoned more tough and durable than the latter, and is used for a great variety of country purposes. It makes excellent charcoal for powder manufacturers, and is much sought after for this purpose; but it is not easily procured in sufficient quantity. It is also particularly adapted for lining to stone-carts and coal-waggons, for which purpose we have cut up and sold large quantities of it. When struck by a stone or any other heavy body, the deal produced from the willow is not readily injured nor split, as is the case with deals made from the fir and pine trees; and it is this quality of the wood which makes it so valuable for the purpose. As a paling rail, it will last much longer than the young wood of the Scots pine or spruce fir.

770. *Soil and situation.*—The white willow requires a good deep soil, somewhat moist, such as that on the banks of lakes and rivers,

to grow so rapidly and profitably as it is capable of doing. However, the best and largest trees we have seen of this kind were in a sheltered glen or ravine by the sides of a stream that ran through it. In such a situation, if the soil is at all moderately good, the trees grow up very rapidly, and attain large dimensions in an astonishingly short time. The tree does well on most soils if not too light and dry, and the situation not exposed.

In order to have the wood of the willow clean and tall for useful purposes, the trees should be planted in a mass and drawn up considerably, and thinned as they require to have more room for development. This is particularly necessary in regard to the white willow, which is very liable to set off into large branches if left to itself in any open part without confinement. But where planted somewhat close together, or mixed with a few firs, it rises to a great height before branching off; and when timeously thinned, excellent timber is produced. As its wood is soft and open in the grain, the willow, and indeed the poplar too, should never be pruned except in the young state. If any branches of considerable size be taken from a full-grown tree, the wound never heals up: the weather takes effect upon the cut part very quickly, and soon produces rot, rendering the timber near it useless.

771. *Propagation and culture.*—No plant is easier of propagation than the willow; indeed, this characteristic is proverbial among practical men. All that is necessary is to put a cutting of young wood into the soil in the spring, and in the autumn following it will be ready for transplanting out into the forest ground. Indeed, many advise the using of pieces of the older wood for cuttings in propagating the willow; but for our own part we have tried both ways, and have always found the cuttings from the last year's wood made the surest and best plants, and ultimately come to be the most rapid-growing and finest trees.

772. This species is very plentifully distributed over the country. Its general dimensions, under favourable circumstances, may be said to be 70 feet high, with a stem averaging 3 feet in diameter. Of such dimensions there are specimens to be found on most places having a favourable soil and site for the tree.

SALIX RUSSELLIANA, or Bedford Willow.

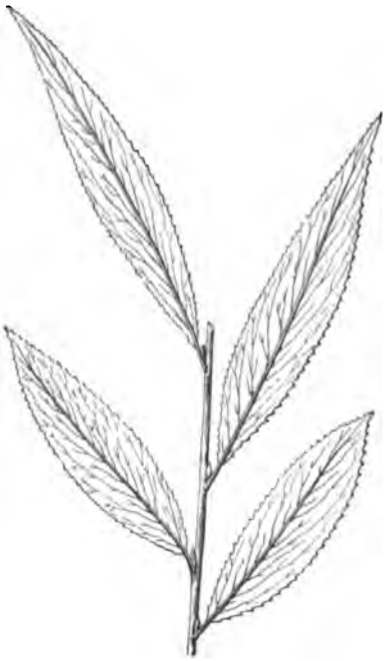
773. *Specific character.*—Leaves lanceolate, acuminate, serrated, smooth. Ovaries pedicellate, subulate, smooth.

774. *Geography.*—This tree is a native of Britain, and found in marshy woods and osier grounds in England.

775. *Description of tree.*—The Bedford willow is another tree which

is well worthy of a place in pleasure-grounds. It gives a much better effect upon a lawn or park than any other of the willow tribe, having a bold outline and rather a rugged habit, which gives it, when viewed from a distance, the appearance of an ash more than that of a willow. As described in the specific character, the leaves of the Bedford willow are *lanceolate*, tapering, and *serrated*, but without hairs, being smooth on both sides; and by this difference alone this tree may be readily distinguished from the former. The leaves are also larger than those of *Salix alba.* Fig. 97 is a representation of the leaves and young wood as in the month of August.

Fig. 97.



776. *Economic uses of timber.*—The timber of this tree is used for the same purposes as have been stated in regard to that of the white willow. There is, indeed, so far as we have been able to notice, scarcely any difference in the quality of the timber of the two sorts, and they are both used alike for all the purposes stated under paragraph 769.

777. *Soil and situation.*—What we have already said in regard to soil and situation as suited to the *Salix alba* is in every respect equally applicable to the tree now under notice. In similar circumstances they both appear to arrive at the same magnitude of timber. When planted upon an exposed situation the branches of the Bedford willow are very apt to be broken down by high winds; but in other respects it is, in our opinion, a more hardy tree than the before-mentioned one.

778. *Propagation and culture.*—These are in all respects the same as stated in regard to the *Salix alba* under paragraph 771.

779. There are many specimens of this species, both in England and Scotland, from 70 to 80 feet high, with stems from 3 to 4 feet in diameter.

SALIX FRAGILIS, or Cracking Willow.

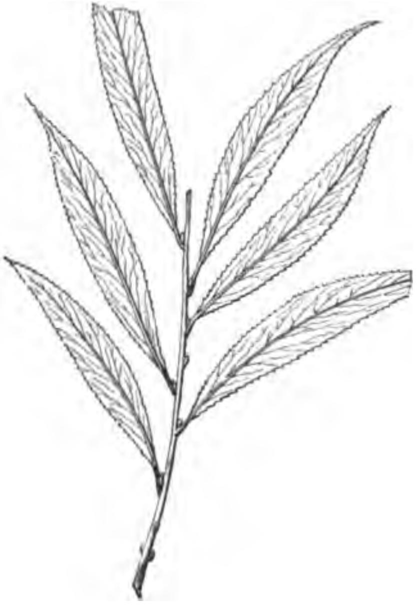
780. *Specific character.*—Leaves ovato-lanceolate, pointed, serrated throughout, very smooth. Foot-stalks glandular. Ovary ovate, nearly sessile. Male flowers with an abortive ovary.

781. *Geography.*—This tree also is a native of woods in Britain.

782. *Description of tree.*—The *Salix fragilis* is a tree comparatively more common in Scotland than in England, where the two sorts already referred to chiefly prevail as timber trees of the genus. It is in all respects a more hardy tree than either of the two former ones, and on this account it is more cultivated in Scotland than they are. In the north of Scotland especially it prevails largely, and is there known as the *red-wood willow,* from the timber having a reddish tinge when cut up. It is there much prized for the usefulness of its timber; and, indeed, in many cold-bottomed lands in the north it grows to a good timber size, and this too upon a very poor soil. This is also a very fast-growing tree. We have seen it, when planted on a good soil and sheltered site, about 70 feet high, and 8 feet in circumference of stem 4 feet from the ground, when only about thirty-five years planted.

The leaves of this sort very much resemble those of the white willow, being slightly downy when young. Fig. 98 is a drawing of the leaves and young wood. There is one peculiar feature in this tree which we may here notice—viz., its aptitude to become what is termed *stag-headed,* when found growing upon a soil not very favourable to its constitution. This is the principal reason that it is so much kept out of lawns and parks, as it thus becomes very unsightly. But as it is a tree bearing as fine a form, when well grown, as the white willow, which we often find in parks, it is an unfair estimate of the tree to keep it out of all park scenery, even when the soil is capable of rearing it properly; and so far as our experience of it goes, we believe that wherever it is planted upon a loamy soil, in which it can have a sufficient supply of nourishment, which is generally the case in hollow parts of parks and lawns, it will not only grow rapidly, but will maintain its health in all parts, as well as any of the other two species.

Fig. 98.



783. *Economic uses of timber.*—The wood of this sort is, in the estimation of most intelligent country carpenters, more durable and tough than that of either of the others; and we have found that we

can sell more of it for country purposes than any other wood of the willow kind. Practical builders say that as a timber for flooring it can scarcely be surpassed, being extremely light, and lasting a long time. It is, generally speaking, used for all the purposes that the timber of the other two kinds is applied to.

784. *Soil and situation.*—This tree will attain respectable dimensions on a greater variety of soils than either the white willow or the Bedford willow will do: still, to grow it well and to large dimensions it requires to be planted on a deep, rather moist soil, and on a sheltered situation.

785. *Propagation and culture.*—This tree is propagated by cuttings in the same manner as the other two sorts referred to, and is, like them, very easy of propagation.

786. The average dimensions of this species, under moderately favourable circumstances, may be said to be 50 feet high, with a stem about 2 feet in diameter. In many parts of the country, however, on very favourable soils and sites, it frequently attains 70 and 80 feet high, with a stem 3 feet and more in diameter.

SECTION X.—THE BIRCH (BETULA)—LINNÆAN SYSTEM, MONŒCIA TETRANDRIA.

787. *Character of genus.*—Barren flower in a cylindrical catkin, its scales 3-flowered; perianth, none; stamens 10-12. Fertile flower,—scale of the catkin imperfectly 3-lobed, 3-flowered; perianth, none; styles 2; germens compressed, 2-celled, one abortive. Nuts compressed, with a membranaceous margin, 1-seeded.

788. Out of fifteen species of birch which are enumerated in our catalogues of plants, we shall refer to three only—viz., the *Betula alba,* or common birch, as it is a useful, hardy, and ornamental tree; and to the two American sorts, *B. excelsa* and *B. papyracea,* as they are highly ornamental species, hardy enough for most parts of Britain, and deserving of culture both in the forest and on the park.

BETULA ALBA, or Common Birch.

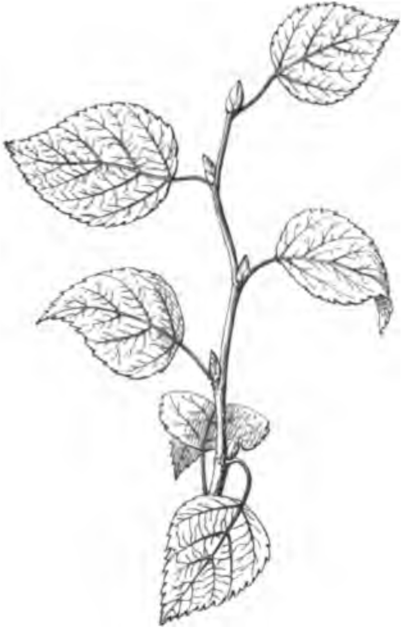
789. *Specific character.*—Leaves ovato-deltoid, acute, doubly serrated, glabrous.

790. *Geography.*—This tree is a native of most parts of Europe, and especially of the northern and mountainous parts. In the extreme northern parts of the continent of Europe it forms only a small tree or large bush, while in the middle parts it grows to a tree of very considerable dimensions—often 50 and 60 feet high. It is indisputably a native of Britain, and forms, even at the present day, con-

siderable natural forests in the north of Scotland. In Strathspey and in Braemar there are natural forests of this tree, which give a most pleasing effect to many of the hill-slopes which otherwise would present a very bleak appearance.

791. *Description of tree.*—The birch is one of the most graceful of all our native trees, and is in consequence generally found in all well-laid-off landscape scenery. As compared with many of our forest trees, it attains at best but very ordinary dimensions as a timber-tree; but it is not so much on account of the value of its timber that the birch is generally a favourite, as on account of its gracefulness—in which respect no forest tree surpasses it. This is particularly the case with the true weeping variety, which is also found wild in many of the higher districts both in England and Scotland. A particular recommendation of this variety is its being of a more rapid growth than the common sort; and on this account the generality of young plants are now raised from the seed of the weeping variety, which is easily known by the drooping tendency of its branches, and also by small white rough spots upon the bark of the young trees. The foliage of the birch is small, and in spring it has a peculiar sweet smell, particularly after a shower of rain. The leaves are what botanists term *ovate-acute,* and somewhat deltoid, doubly serrated, and nearly smooth. Fig. 99 is a representation of these.

Fig. 99.



792. *Economic uses of timber.*—The wood of the birch is by no means of great durability, in whatever situation it may be placed. We have seen it used in a great variety of ways, both for outside and inside work, and find it, in the open air, as in the case of a post in a fence, of very inferior durability, not lasting more than three years,—in this respect resembling the beech. Even when used for furniture, it is very soon affected by rot. It is much used for making herring-barrel staves, for which purpose it suits excellently; and it is much sought after for making charcoal for gunpowder manufactories. But perhaps the most important use to which the wood of the birch is applied is that of making *bobbins*

for thread manufactories. Very large quantities are used for this purpose now, and the advantage of this to the grower of the wood is, that for bobbins he can dispose of even the branches down to one inch in diameter.

793. *Soil and situation.*—In duration as a tree the birch is not to be compared with the oak or sycamore; but in a good dry soil suited to its constitution it lives to a great age. The birch is a tree by no means particular as regards soil and situation—in fact, it is one of the most hardy trees we possess, being found to exist as a low tree in the mountainous districts of Scotland, at an elevation of fully 3000 feet above the level of the sea. But notwithstanding this hardihood, it does not attain respectable dimensions unless planted upon a fair soil, and at an elevation something under 1500 feet above sea-level. This tree delights naturally in a dry sandy or stony soil, which is generally of a poor quality; but the largest specimens of it that we have seen grew upon a sandy loam, having a bottom by no means of the driest nature; and as far as we have observed its natural habits, it does not disagree with a little moisture, provided this is not allowed to remain stagnant about the roots.

794. *Propagation and culture.*—This tree is raised from seed, which is generally ready for gathering about the first week of October. When gathered, it should be kept in a dry and airy loft or room all the winter, and should be sown in the month of March. In sowing it, care should be taken that the earth upon which it is sown be very finely wrought by the spade and rake. The soil ought to be light, and the surface made as fine as oatmeal before sowing; and even in the act of covering in the seed, great care is necessary to see that it is not covered too deep: in fact, the slightest covering of earth is sufficient, and this, too, should be of the finest quality. The seed is always sown on beds about 3½ feet broad. When the soil cannot be got of a nature fine enough, a very good plan is to sow upon the prepared surface, and give the seed no covering at all, but merely a slight beat with the back of the spade, in order to keep the wind from blowing it about. By this plan we have seen excellent crops of young birch raised.

About the first week of June the plants will be seen to come up in abundance thickly all over the beds; and as they are easily hurt by weeds, they should receive every attention in the way of keeping them clean.

One year after the seeds have been sown, the young plants may be lifted and transplanted out into rows in the nursery-ground,—and when they have stood two years in that state, they may be put out into the forest-ground; but if wanted of a larger size, they should be allowed to remain in the nursery another year.

The birch is an excellent tree for planting on exposed parts of an enclosure where there is little soil, and that poor and thin, as on such parts it will soon make a cover, and ultimately become a more valuable crop than any other tree that could be used on them.

As a coppice-wood, the birch answers well; indeed, in several instances we have found birch coppice more profitable than oak, as the small wood of it can always be sold either for powder-wood or bobbin-wood, while that of the oak cannot.

795. At Aboyne Castle there is a birch-tree 50 feet high, with a girth of 9 feet near the bottom. In the forest of Ballochbuie, on the estate of Invercauld, Aberdeenshire, there is a tree of this species which measures 6 feet 8 inches in circumference at 4 feet from the ground.

BETULA EXCELSA, or the Tall Birch.

796. *Specific character.*—Leaves ovate, acute, serrated. Scales of cones with lateral lobes, rounded. Petioles downy, shorter than peduncles.

797. *Geography.*—This tree is a native of North America, and was introduced into Britain in 1767. We have found it on deep and rather moist lands — on most parts of Upper Canada, especially in the valley of the Ottawa, where it is very plentiful in the natural forests.

798. *Description of tree.*—The leaves of this tree are large compared with those of the common British birch, being generally from 3 to 4 inches long, and from 2 to 3 inches broad, with sharp irregular teeth on their margins. In the natural forests of Canada it forms a tall stately tree, often rising up to a height of from 80 to 90 feet, with a stem of from 2½ to 3½ feet in diameter. In some instances where we have seen this tree lying felled, we have measured and found it 95 feet high, with a stem nearly 4 feet in diameter; but generally speaking they are not so large, measuring only from 70 to 90 feet high, with stems from 2 to 3 feet in diameter. When this tree stands alone, it forms a fine ornamental object, being clothed with branches, and their leaves down nearly to the ground. We have seen specimens of this species on the sides of rivers and lakes in America, which were truly of an ornamental character, being well clothed with branches down to the water's edge, and presenting festoons the most perfect imaginable. We therefore recommend this tree as an ornamental one on parks and lawns in Britain, as in such situations it would make a fine contrast with many other of our common trees, as its habit is to grow upright, and to become clothed with branches from top to bottom when grown in an open part and on a suitable soil.

799. *Soil and situation.*—This species requires a good, deep, and rather moist soil to grow well upon. We have indeed seen good specimens of it on dry grounds in Canada, but in all cases we have found the largest and best developed specimens on the sides of rivers and lakes, and on the edges of swamps, where there was sufficient moisture for their roots without its being stagnant about them. The tree requires also to be planted in a sheltered situation, as although it is quite hardy enough to stand in the climate of Britain, still it will not grow to a good size unless on a low-lying site, sheltered with other trees.

800. *Propagation and culture.*—This tree is propagated by seeds imported from America, which may be had from any extensive dealer in foreign tree-seeds. The species is as easily raised from seed as the common birch, and the same treatment is necessary in rearing them both.

BETULA PAPYRACEA, or the Paper Birch.

801. *Specific character.*—Leaves ovate, acuminate, doubly serrate, veins hairy beneath.

802. *Geography.*—This tree is also a native of North America, and was introduced into Britain in 1750. In Canada we have found specimens of it attain very large dimensions, not unfrequently from 90 to 100 feet in height, with a diameter of stem exceeding 4 feet 6 inches, but in general cases it does not attain much over 70 feet in height, with a stem from 30 inches to 3 feet in diameter. It is plentiful on good lands all over Upper Canada, and is generally found in the neighbourhood of the tall birch, but upon drier parts of the land.

803. *Description of tree.*—This species is easily known from the tall birch by its leaves being smaller, and darker green. Its branches are also more slender than those of the tall birch, and its bark is more silvery and shining. It forms a beautiful object in the Canadian forests, giving the parts of them on which it grows a lively aspect among the limes, maples, and others that grow with them. The native Indians of Canada make their canoes from the bark of this species, and we have frequently seen them engaged stripping it from trees for this purpose. This also forms a fine ornamental tree on a park, its beautiful white bark contrasting well with the dark green of its leaves, which, in well-grown specimens, are well furnished and plentiful on the branches. Both this species and the tall birch are well worthy of cultivation on the parks and lawns of landed proprietors in Britain; and as we are aware that they are quite hardy enough for most places at all favourably situated, we here beg to recommend them to the notice of landed proprietors, as they are as easy

of cultivation as the common British birch; and from being of stronger growth, they are calculated to give an effect upon the landscape much sooner than it, and that too of a somewhat different character. The leaves being larger, and easily agitated by the breeze, give a peculiar effect when contrasted with the silvery hue of the bark on the stems.

804. *Soil and situation.*—This tree, we should say, judging from what we have seen of it in its native forests, requires a deep and dry soil, and somewhat rich in vegetable matter. We have never found it on soil of a wet character, such as that on which the tall birch is generally found, but upon gentle swells and ridges which are dry in the subsoil. Like the tall birch, it will not succeed on an exposed site, but should have a low-lying situation, with the shelter of other trees.

805. *Propagation and culture.*—This species also is raised from seeds, imported chiefly through the New York seed-dealers. The seed of both this and the tall birch can be had cheaply from seed-merchants in New York; and any nurseryman in Britain could have no difficulty in rearing large quantities of these trees, and at a cheap rate, provided he had orders for them from landed proprietors. As they have been very little inquired for, they have not been much reared, and hence they are scarce and high in price; but were there a demand for them, nurserymen here would attend to grow them, and consequently they could be had at a moderate cost.

SECTION XI.—THE ALDER (ALNUS)—LINNÆAN SYSTEM, MONŒCIA TETRANDRIA.

806. *Character of the genus.*—Flowers collected into imbricated catkins; barren flowers,—scale of the catkin 3-lobed, with 3 flowers; perianth single, 4-partite; fertile flowers,—scale of the catkin subtrifid, with 2 flowers; perianth, none; styles 2; fruit compressed.

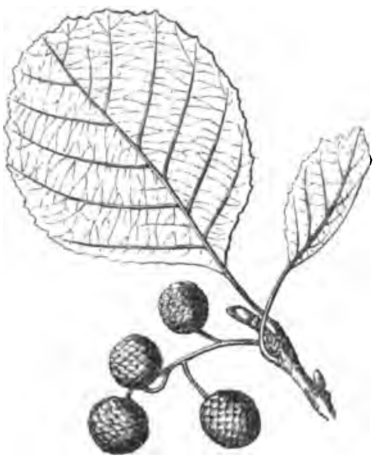
807. All the species of this genus are small trees, some of them scarcely attaining tree size, but merely that of shrubs, and none of them can be said to be ornamental. The only species to which we think it necessary to refer here is the *Alnus glutinosa*, or common alder, which is sometimes found a useful tree for planting on cold, wet sites, where few other trees would succeed.

ALNUS GLUTINOSA, or Common Alder.

808. *Specific character.*—Leaves roundish, cuneiform, obtuse, lobed at margin, and serrated, somewhat glutinous, downy in axils of veins beneath.

809. *Geography.*—The common alder is found all over Europe, and always in moist places, such as swamps. Indeed it is found growing in situations which are too wet for either poplars or willows to succeed. It is found also along all the northern parts of Asia, and in the north of Africa. This may be said to be truly a native of Britain, being found wild along the banks of our rivers and marshy parts of our waste lands. In these cases it is seldom found of large dimensions, but generally as a large bush, or at least as a small deformed tree.

Fig. 100.



810. *Description of tree.*—Fig. 100 represents the leaves of this tree, and also the catkins containing the seeds. In the wild state the tree seldom attains the height of more than 40 feet, but where attention has been paid to it, and it has got the same management as other forest-trees, it attains a size by no means despicable, being frequently found upon a good loamy soil from 50 to 60 feet high, and of proportionate scantling; but in no case will it attain a large size unless it has a considerable degree of moisture for its roots, which is always found by it upon the margins of rivers. The bark of the common alder, in the case of oldish trees, is nearly black, and full of clefts; and the branches, when they are young, and the tree is in a state of vigorous growth, have a triangular form, but when mature they are round. This tree is well known all over Britain, as there are few wet parts by the sides of our smaller rivers where it is not found luxuriating; therefore we need not make any further remarks descriptive of it, especially as the figure showing the leaves and seed catkins is enough to enable any one to distinguish the tree from any other.

811. *Economic uses of timber.*—The wood of the alder is by no means valuable, nor is it generally applied to many purposes. It is reckoned one of the most lasting of all woods for any underground work, such as piles for bridges; and it is even allowed to stand a long time when covered from the effects of change of dry and moist. So far as our own experience goes, this wood is the one which of all others we incline to reject in the making of any common outdoor work, such as fencing; in fact, we have found posts of this wood useless in less than one year, they being rotten at the part between

the earth and the air. Still, both as a tree crop and as a coppice-wood, we have found it very valuable for the purpose of making charcoal for powder manufactures, and for sawing up for herring-barrel staves, for both of which purposes it is much sought after, and sells readily in most parts of the country.

812. *Soil and situation.*—The alder is by no means particular as regards quality of soil, but moisture is indispensable. In travelling through the Highlands of Scotland, and some of the northern hilly parts of England, we find large tracts of this tree, which is always found luxuriating in the swampy low-lying grounds, and on the margins of rivulets; and this at once points out the circumstances favourable to its growth. However, we may remark also under this head, that the alder will attain its largest dimensions of timber and top branches when planted on any low-lying site, having a strong soil with a moist bottom, such as the poplar and willow are found to thrive well upon. On such situations, we have seen the alder attain the height of 50 and 60 feet, with a stem from 2 to 3 feet diameter, forming very respectable trees.

813. *Propagation and culture.*—The alder is sometimes propagated by cuttings and layers of the young wood, but principally from the seed. Indeed, although the method of propagating it by cuttings is sometimes resorted to, the plants raised by such means are of little real worth, and never arrive at the character of a tree as those do which are raised from the seed. The young plants ought, therefore, in all cases where healthy young trees are desired, to be raised from the seed. Of course we do not here mean these remarks to apply to the extending or propagating of the *varieties* of this genus, such as the *A. laciniata*, or cut-leaved variety, and others, which must be propagated by cuttings or layers, in order to have them after their true characters.

The seeds should be gathered in the month of October, or at least as soon as the scales of the catkins or seed-vessels begin to open a little. When the catkins are gathered, they should be well exposed to the sun upon a sheet for a few days in the open air, when the scales will open widely, and allow the seed to be separated by a slight rubbing and turning with the hands. Many seedsmen, when they gather the seed of the alder, simply lay it past in a dry room, and turn it frequently till the seeds fall out of their own accord. It should be sown in the month of March and slightly covered. When the plants have stood one year in the seed-bed, they should be planted out into rows in the nursery-ground, and there they may be allowed to remain one or two years, according to the strength that the plants may be required to be.

SECTION XII.—THE SWEET CHESTNUT (CASTANEA)—LINNÆAN SYSTEM, MONŒCIA POLYANDRIA.

814. *Character of the genus.*—Barren flowers in a very long cylindrical catkin. Perianth single, of 1-leaf, 6-cleft. Stamens 5-20. Fertile flowers 3, within a 4-lobed, thickly muricated involucrum. Perianth single, urceolate, 5-6 lobed, having the rudiments of 12 stamens. Germen incorporated with the perianth, 6-celled, with the cells 2-seeded, 5 of them mostly abortive. Styles 6. Nut 1-2 seeded, invested with the enlarged involucre.

815. There are only two species of this tree named in our catalogues of plants—viz., the *Castanea vesca*, which may be said to be a native of Europe, and the *C. pumila*, or dwarf chestnut, which belongs to North America. The former species, with many varieties of it, is much cultivated on the continent of Europe, and especially in Italy and France, for the sake of their fruit; and as this tree is a very ornamental one, and grows to large dimensions, we shall refer to it only. The other species being only a large bush, found in the Southern States of North America, need not be referred to, as it is of no importance as a timber-producing plant.

CASTANEA VESCA, or Common Sweet Chestnut.

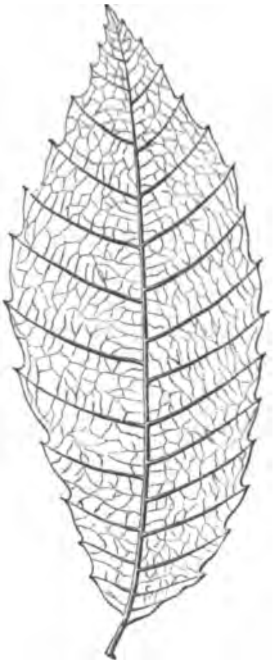
816. *Specific character.*—Leaves oblongo-lanceolate, acuminate, mucronate, serrate, glabrous on each side.

817. *Geography.*—The sweet chestnut is found in the east and west of Asia, in the north of Africa, and is also plentiful in the woods of North America. It is said to be found in the wild state in some parts of Italy, France, and Spain, but is evidently not a native of Britain, although it has been cultivated in the country from time immemorial.

818. *Description of tree.*—This is a tree which, in a favourable situation, attains large dimensions, frequently surpassing the oak in this respect; and when grown in an open park or lawn, it is a highly ornamental tree, its general bearing at a distance very much resembling that of the oak; and in the autumn, when its leaves take on a yellow colour, it has a beautiful effect among other trees of darker foliage. Cultivated in these circumstances, also, it lives to a great age. As a timber-tree, however, it falls far short of even what we may consider as our secondary sorts. It does not even attain large dimensions, unless it have the advantage of a good loamy soil and a good situation, and is therefore not adapted for generally planting out as a forest-tree in any exposed situation upon an indifferent soil.

The foliage of the sweet chestnut is full upon the young wood, and has a very fine effect in the early part of summer, as well as in the autumn, when it begins to take on the yellow tinge. The leaves are what is termed by botanists oblongo-lanceolate, acuminate, and mucronately serrated (see fig. 101). When young, the tree grows very rapidly, and very soon attains a large size; but we have seldom seen one which had arrived at the age of 60 years which was not *ring-shaken* in the heart-wood, and, in fact, almost useless for any particular purpose. It is, however, excellently adapted for coppice-wood; and in all districts where there may be a demand for hop-poles of various sizes, the sweet chestnut pays well in the form of coppice. It readily throws up a succession of young shoots from the stoles when cut over, which grow very rapidly for the first eight or ten years, frequently at the end of that period producing shoots from 4 to 5 inches diameter, and from 20 to 30 feet high, and these, too, very numerous round the stoles.

Fig. 101.



819. *Economic uses of timber.*—The wood of the sweet chestnut is generally found good and sound, and available for many useful purposes, up to the age of about 60 years; and as a secondary tree, or one which is grown for a time among others which may be meant to stand as a permanent crop upon the ground, it is well adapted. The wood of the sweet chestnut is undoubtedly very durable. For gate-posts and general fencing purposes we have found it answer most excellently; and even for cart and waggon shafts it answers well when from 30 to 40 years' old, and for many other purposes besides. In North America, where this tree is found plentiful and of large dimensions, the wood is much used for the purposes of fencing and house-building, and for these purposes no wood is better suited. We have ourselves seen in Canada fences made of this wood, which had stood exposed to the weather for upwards of twenty-five years, as good as they were at the time they were put up.

820. *Soil and situation.*—The chestnut requires a deep and dry sandy loam to prosper well in. It does not succeed on stiff clays, nor on any cold-bottomed lands, but it grows well on most dry-bottomed lands, although not rich, if well sheltered. We have even seen excellent crops of chestnut timber on lands of a stony and gravelly nature, which were poor, but these were well sheltered and warm-lying. In

Britain, a sheltered site and a dry-bottomed soil are what is required for the profitable growth of the sweet chestnut.

821. *Propagation and culture.*—The sweet chestnut is propagated in exactly the same manner as the oak, and what has been said relative to the oak is equally applicable to the sweet chestnut, but with this exception, that the chestnut is generally, when young, of a more rapid growth than the oak, and is therefore ready for transplanting into the forest ground after having been two years in the nursery rows. It may be remarked here that the nuts of this tree are procured from America, and from France, Italy, and Spain, as they seldom ripen in Britain. As the nuts are large, they should be sown more thinly than the acorns of the oak, and should also be covered more deeply, say not less than 3 inches.

822. It would be superfluous to name the dimensions of this tree on particular places, as there are few old wooded parks in Britain which have not their fine ornamental specimens of the species as well as those of the oak. Suffice it to say, that under favourable circumstances of soil and situation the tree attains the average height of 70 feet, with stems from 4 to 6 feet in diameter. There are many specimens of much greater dimensions on various places, but what we have stated may be taken as an average of the growth of the tree under favourable circumstances.

SECTION XIII.—THE HORSE-CHESTNUT (ÆSCULUS)—LINNÆAN SYSTEM, HEPTANDRIA MONOGYNIA.

823. *Character of the genus.*—Calyx 1-leaved, inflated; corolla 4-5 petalled, unequal, pubescent, inserted in the calyx. Capsules 3-celled; seeds large, chestnut-like.

824. The only species of this genus worth referring to as a timber-tree is the *Æsculus hippocastanum*, which is a tree of great magnitude and beauty, and therefore well deserving a place in any park, as it may be said to be the only flowering large tree we have upon our lawns.

ÆSCULUS HIPPOCASTANUM, or Common Horse-Chestnut.

825. *Specific character.*—Leaves digitate, seven; petals 5, spreading.

826. *Geography.*—This tree is a native of Asia, and was introduced into Britain, by way of the continent of Europe, about the year 1629.

827. *Description of tree.*—This is a tree of very rapid growth, and in a few years attains very considerable size. It is by no means a delicate tree, although a native of Asia; it is, in fact, a hardy tree as far as regards the degree of cold which it can bear, but from the short-

grained texture of the wood, which is brittle, it is not at all adapted to grow in an exposed situation. The leaves have a very fine massive effect when the tree is placed among others of a more light and airy character; and as they appear pretty early in the season, accompanied by the rich pink-white flowers, the tree is upon that account more worthy of a place upon the lawn. The naked tree is of itself of a stiff character, the young shoots being large, and not numerous. See fig. 102, which is a representation of the young shoots, and fig. 103, representing the form of the leaves upon a reduced scale. The rapid growth of the young wood of this tree is remarkable, the shoots of the year's growth being generally perfected within one month of the time of the opening of the leaf-buds. This tree, when standing on an open park, has a tendency to spread out massive limbs rather than to grow to height of stem, and in this form it is always most ornamental, being clothed with branches from bottom to top, which spread out a large surface of leaves, with their accompanying flowers, which produce an admirable effect in the month of May.

Fig. 102.

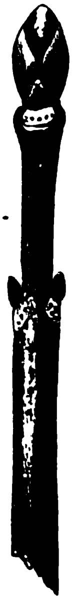
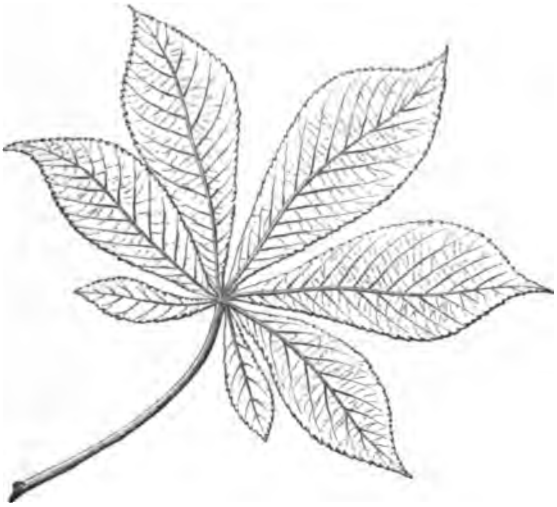


Fig. 103.



828. *Economic uses of timber.*—Although the wood of this tree is soft, and by no means adapted for purposes in which durability and strength are objects, still there are many purposes for which it is useful, such as flooring, waggon-bottoming, turnery-work, and many of the purposes to which the timber of the poplar and willow are applied. In Britain, however, the tree is never cultivated with a view to its

timber, but solely as an ornamental one, and as such it is well known to every one at all acquainted with trees. It is an excellent tree for planting on the sides of roads near towns, as the smoke does not seem to injure it much, but it is of too spreading a habit to be recommended as a tree for planting on the sides of streets in towns.

829. *Soil and situation.*—In order to attain large dimensions, and to have the appearance which its massy foliage and heavy limbs are calculated to produce, it requires to be grown upon a good rich loamy and dry soil, and in rather a sheltered situation; at least, it must be in a situation where it is not apt to be exposed to severe storms of wind, such as on a park among other trees, or on the sides of roads in plantations.

830. *Propagation and culture.*—This tree is propagated from the seed, which is termed a nut. These are generally ripe in the month of October, and they should be sown immediately when gathered, as they are extremely apt to lose their vegetative powers if kept long. They should be sown in rows, in the same way as has already been recommended for the nut of the sweet chestnut. The young plants make vigorous shoots the very first year, and are fit for being transplanted out into nursery rows when one year old, in which they may remain for one year or for two years, according as the plants may be wished to be small or large. It is perhaps unnecessary to remark that the nuts ripen freely in this country, and should be gathered before they fall from the trees, which they generally do in the month of November.

831. This tree also attains very large dimensions under favourable circumstances, being frequently found from 70 to 80 feet high, with stems from 4 to 6 feet in diameter.

SECTION XIV.—THE LIME-TREE (TILIA)—LINNÆAN SYSTEM, POLYANDRIA MONOGYNIA.

832. *Character of the genus.*—Calyx 5-parted; petals 5; capsule coriaceous, globose, 5-celled, 4-valved, opening at base, 1-seeded.

833. Loudon, in his 'Encyclopædia' of plants, describes four species of the lime-tree as natives of Britain, three as natives of North America, and one as a native of Hungary. We shall, however, refer here only to the species which are given as natives of Britain, as, whether as timber or as ornamental trees, they are very much superior to the others. The four sorts described by Loudon as species, and as natives of Britain, are *Tilia rubra,* or common lime-tree; *T. intermedia,* or intermediate lime; *T. parvifolia,* or small-leaved lime; and *T. platyphylla,* or broad-leaved lime. Although, however, these four sorts are described as species, still there seems to be every reason to conclude

that they are only varieties of the one tree—namely, the EUROPEAN LIME-TREE; and with this view we shall describe them all under one head, and as one tree—namely, the TILIA EUROPÆA, or the common European lime—because there is really no difference worth mentioning in respect to the general habits and peculiarities of the trees, all requiring the same treatment in their general cultivation, &c.

TILIA EUROPÆA, or Common Lime-Tree of Europe.

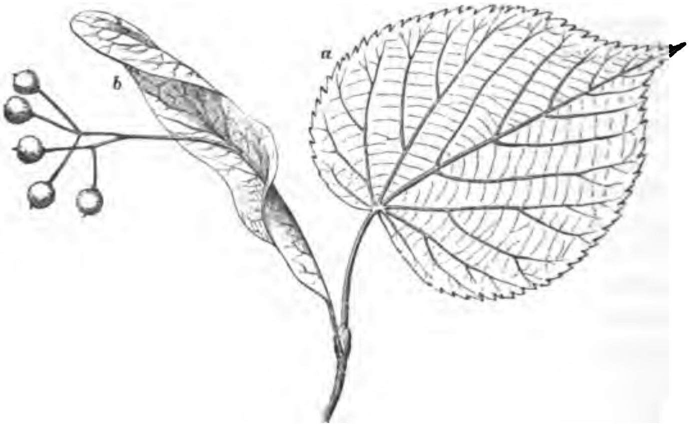
834. *Specific characters* of the four sorts named above, as given by Loudon: *T. rubra,*—leaves cordate, unequal at base; petioles and suckers hairy; axil of veins beard beneath; fruit globose, smooth. *T. intermedia,*—leaves cordate, acuminated, serrated, smooth, twice as long as stalks; axil of veins beard beneath; fruit membraneous, oblong, deformed, 2-seeded. *T. parvifolia,*—leaves cordate, round, acuminated, finely serrated, smooth, scarcely longer than stalks; axil of veins beard beneath; fruit round, very thin and brittle. *T. platyphylla,*—leaves cordate, round, acuminated, finely serrated, a little downy beneath; fruit turb., woody, with prominent ribs.

835. *Geography.*—The lime-tree is found in the Alps of Switzerland and on the north of Italy, and also in Spain and Portugal. It it found also in Russia, Sweden, and Germany. It is by many considered a native of Britain as well, but, for our own part, we are decidedly of the opinion that it is not, as the tree, in none of its varieties, ripens seeds in this country, except in rare instances, which is at once proof that the tree is not truly indigenous to Britain. It has been cultivated in Britain from time immemorial, and, consequently, like some others of our trees, has become so far naturalised as to be constitutionally as hardy as a native.

836. *Description of tree.*—The lime-tree is one of the most beautiful and interesting of our ornamental trees in the month of July, when in full flower, with leaves in their freshest state. Many object to it as being of a stiff and formal outline and a clumsy habit, and as not presenting that light and shade which are required for picturesque scenery. This is no doubt true; but in well-chosen situations, such as along the sides of walks or avenues, it is one of the most desirable of trees. Even when standing singly, freely exposed to the open air, and when contrasted among other trees, it forms a beautiful object when in full flower; indeed, as an ornamental tree, in almost any situation, few will object to its presence. This is a tree which, under favourable circumstances, attains very large dimensions, and lives to a great age,—often attaining a height of 100 feet, with a stem over 4 feet diameter near the ground, and in a sound state of timber when upwards of 200 years old.

The leaves of this tree are of a fine light green, and are described by botanists as *cordate*, *acuminated*, and *serrated* (see fig. 104, *a*).

Fig. 104.



There is a peculiar appendage attached to the peduncle of each of the cymes of flowers of the lime-tree, termed the floral leaf, out of which the flowers protrude, as it were (see fig. 104, *b*).

837. *Economic uses of timber.*—The wood of this tree is white in colour, and of a peculiarly close and soft nature, being particularly well adapted for all kinds of turnery-work. It is much sought after for boards upon which to cut leather. It is also used in the making of musical instruments, as in the case of sounding-boards for pianofortes, for which purpose we have sold large quantities of it. It is also used in the making of charcoal for gunpowder. In Russia and Sweden, the inner bark of the lime-tree is manufactured into the bass-mats which are so much used in this country for various purposes.

838. *Soil and situation.*—The lime-tree is found to thrive well on a great variety of soils, if not too poor and too dry, and if not exposed to points of storm. We have found it of large size on a deep, rich, light loam, when it was well sheltered among other tall trees; but the best specimens we have seen grew upon a strong, deep clay loam, rather of a moist nature than otherwise in the subsoil. From our experience of the lime, we should say it succeeds best on a good strong loam, and on a low-lying and sheltered part of the country; but still it becomes a fair and handsome tree on lighter lands, if deep and well sheltered. The lime-tree is one which we have found very easy to transplant with safety at a considerable age and size. Hence it is very useful in filling up gaps, or for making groups to have immediate effect upon a lawn.

839. *Propagation and culture.*—The seeds very seldom ripen in

Britain, that only taking place in very fine seasons; therefore the tree is generally propagated by layers, by which mode it is very readily multiplied. It being a soft-wooded plant, it easily strikes root by layering. Nurserymen in Britain sometimes get seeds from the Continent, however, where they ripen perfectly; but as the plants raised in this way take a long time to attain sufficient size for sale, and for transplanting into their permanent sites, the mode of rearing them by layering is most generally adopted, as by this mode they can be reared of a given size in half the time that is required to have the same size of plants by growing them from seed. In rearing the lime from seed, the seeds, as soon as received, should be sown, because, if they are preserved dry till the following spring, they will not come up equally—many of them not till the second year. Some, however, mix the seeds with sand, or very fine earth, which should not be too dry to extract the natural moisture from the seeds, nor so damp as to induce rot in them. Kept in sand or fine earth not too dry, they should be sown the following spring, and will come up equally in summer. For the reasons stated, however, layering is the mode by which the plant is generally propagated in our nurseries; and when the layers are one year old, they may with all safety be removed from the parent stock and transplanted into the nursery rows, where they may remain for one, two, or even three years, according as the plants may be wished to be large or small.

It may be remarked here, that there are no fewer than fourteen varieties of the common lime-tree enumerated in the catalogues of British nurserymen, all of which are of course multiplied by layering.

840. The lime-tree, on favourable soils and sheltered sites, attains large dimensions, there being few places of any standing in Britain which cannot boast of trees of this species which are upwards of 70 feet high, with stems over 4 feet in diameter. On many places, however, they are found even from 90 to 100 feet high, with stems from 5 to 6 feet in diameter.

SECTION XV.—THE WALNUT-TREE (JUGLANS)—LINNÆAN SYSTEM, MONŒCIA POLYANDRIA.

841. *Character of genus.*—Male, an imbricated catkin; calyx a scale; corolla 6-parted; filaments 4-18. Female, calyx 4-fid. superior; corolla 4-fid.; styles 2. Drupe coriaceous, with a furrowed nut.

842. There are many species and several varieties of the walnut, chiefly natives of North America, but the only one we shall refer to here is the common walnut (*Juglans regia*), which is understood to have been in cultivation in Britain since 1562.

JUGLANS REGIA. The Royal or Common Walnut-Tree.

843. *Specific character.*—Leaflets about nine, oval, smooth, subserrated, nearly equal; fruit globose.

844. *Geography.*—The walnut is a native of Persia, and also, it is said, of the north of China. This tree is cultivated in every part of Europe, as far north as Warsaw, both for its fruit and timber. In Britain it generally ripens its fruit in most parts of the country lying to the south of the river Forth, but to the north of this it may be said to do so only in fine seasons.

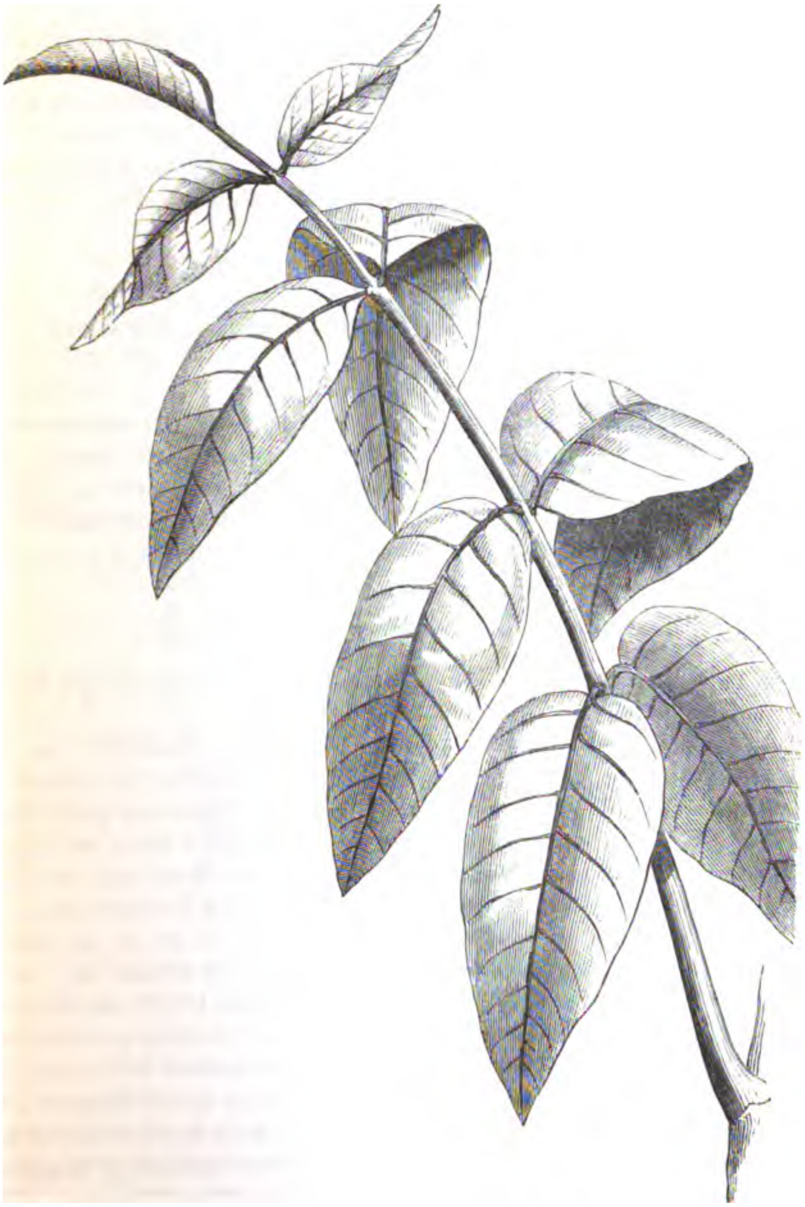
845. *Description of tree.*—The walnut in Britain becomes, under favourable circumstances, a tree of very considerable dimensions, producing a thick stem with ample spread of top. When the tree becomes of considerable age, it has a thick and deeply furrowed bark on the stem, but on the branches it is generally a lightish grey, and smooth. The leaves, especially when bruised, have a strong aromatic smell, often very strong in the warm weather of summer. The leaflets are generally in three or four opposite pairs, with an odd terminal one, and are oval shaped, smooth, and somewhat serrated. (See fig. 105.)

846. *Economic uses of timber.*—This tree has hitherto been cultivated chiefly for its fruit, but there can be no doubt that it might be turned to good account for its timber also. When the tree is young its timber is soft and white, and worthless as compared with that of most other young trees; but after it has attained from 50 to 60 years, it becomes hard and solid in the interior of the tree, till about 80 years it becomes of a very solid texture, of a dark-brown colour, and beautifully veined. It is very much sought after for furniture purposes, and for these it brings a high price when of really good and solid quality. It is also much sought after for gun-stocks, as no description of wood has been found so suitable for this purpose. In most parts, however, this tree is cultivated for its fruit, which is much in demand for the table in most parts of the civilised world. In a young and green state it is pickled and preserved, and when ripe it is used as dessert by all classes who can afford it; while in the countries where it grows plentifully, the poorer classes use it as food.

847. *Soil and situation.*—To grow this tree well, and to a really valuable size, it requires to be planted in a deep and strong loamy soil, rather light than heavy, and by all means deep and dry, as it sends down large and strong tap-roots, and if these get down into wet or bad subsoil the tree will not prosper. It will thrive on a considerable variety of soils, if these are of a deep, light, porous, and dry nature, but will not succeed on a heavy or cold-bottomed land.

848. *Propagation and culture.*—This species is always grown from the nuts, which are generally ripe about the 1st of October. They should be sown in rows, and covered to the depth of 2½ inches. As they are very apt to lose their vitality if long kept, they should be sown as soon as possible after they come to hand, whether they may

Fig. 105.



be imported or grown in the country. As the plants make strong tap-roots the first year, they should be lifted when only 1 year old and planted out in lines, which will cause them to become more fibrous and safe to plant out into their permanent sites. There are varieties of this tree, and these are propagated by budding, grafting, and layering.

849. The average dimensions of this species, in favourable soils and sites in Britain, may be stated as 60 feet high, with stems from 30 to 36 inches in diameter. It indeed sometimes attains the height of 80 and 90 feet, with stems over 4 feet in diameter, but these are exceptional cases.

SECTION XVI.—THE TULIP-TREE (LIRIODENDRON)—LINNÆAN SYSTEM, POLYANDRIA POLYGYNIA.

850. *Character of genus.*—Calyx 3-leaved; petals 6; samaræ imbricated in a cone; capsules 1-2 seeded, not opening, attenuated.

851. There is only one distinct species of this tree, the *L. tulipifera*, which is a free-growing tree, attaining a large size in this country, and especially in the southern and midland counties of England.

LIRIODENDRON TULIPIFERA, or Common Tulip-Tree.

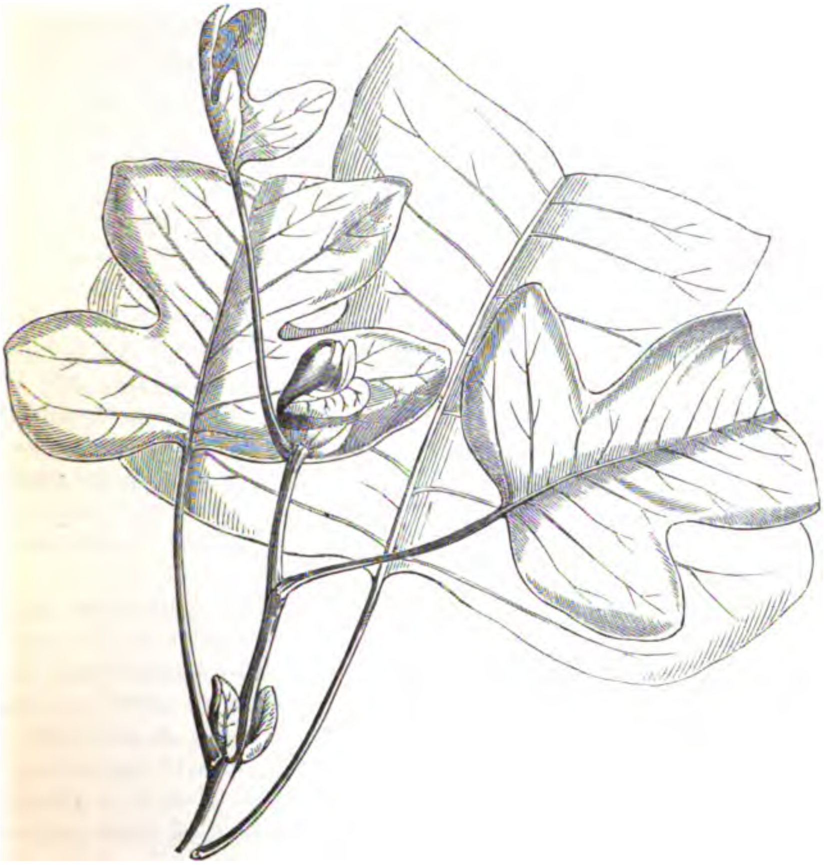
852. *Specific character.*—Leaves truncate at end, with two broad opposite stipules.

853. *Geography.*—This tree is found growing naturally in the woods of Canada, and those of the United States as far south as Carolina and Georgia, and very abundantly in Tennessee and Kentucky. We have ourselves found it in the southern parts of Upper Canada, but never in the northern parts of that country, and we have seen it plentiful in New York State, and in that of Pennsylvania.

854. *Description of tree.*—This tree is easily known by its leaves, which are quite characteristic, and unlike those of almost any other tree, very much resembling a riding-saddle (see fig. 106). In America we have seen beautiful specimens of this tree growing naturally in the woods, and where they have space to develop their branches they form splendid objects in the month of July, when in full flower. We have found them from 90 to 100 feet high, with stems from 2 to 4 feet diameter, and as straight as an arrow, with spreading tops covered with their pretty cream-coloured tulip-shaped flowers. The foliage of this tree is of a very rich and peculiar character, the leaves being large, of a beautiful light shining green, and having a tendency to move from side to side when acted on by a very slight breeze.

We consider this one of the most ornamental trees we have from America; and from having seen it in its native soil and climate, we strongly recommend it to be planted more than it has been as an ornamental tree for the parks and lawns of proprietors' seats in Britain, especially as it is perfectly hardy in most parts of the country, and when of some age forms a fine spreading-topped tree, bearing flowers in some seasons in great profusion.

Fig. 106.



855. *Soil and situation.*—Although this tree is, generally speaking, hardy enough to stand the climate of this country on favourable parts as far north as the southern slope of the Grampians, still it is comparatively tender, and succeeds only in well-sheltered situations, and on a deep, dry, loamy soil. The best specimens that we have seen in Britain stood on lawns where there was a considerable degree of shelter, from the presence of other larger and branchy trees, and at the same time where they had full exposure to light and air to

ripen their wood. In America it is found growing on all kinds of soil and situations, but the largest specimens we have seen of it there grew on a flat part of the country, on a deep loamy land, rather inclined to be wet in the subsoil. Even in its native parts, it requires shelter to develop itself perfectly, and this should teach us how to deal with it here. In giving it a sheltered place, however, as already hinted, it should in all cases have free open space around it, in order to admit the rays of the sun and free air, as unless planted in these circumstances it will not ripen its wood and buds perfectly, and consequently would not flower.

856. *Propagation and culture.*—Although, generally speaking, the *Liriodendron* grows well in the more favourable parts of this country, and flowers profusely, it ripens its seeds only in very favourable seasons, even in England. The supply of seed for the raising of a stock of plants is therefore got from America. The seeds should be sown as soon as they are received, which may generally be in the autumn. If this is attended to, the plants will come up the following spring; but if they should not be sown till spring, they will in all probability lie dormant till the next spring. The seeds should be sown on a very light and fine soil, or on a sandy loam; and a good plan is to do so in a bed or cool frame, taking care to keep the earth rather moist than otherwise, and to shade the frame with a thin net till the plants have come up, when the shading may be gradually removed.

As the young plants are not furnished with fibrous roots, they should not be allowed to stand more than one season in the seed-beds. At the end of the first year they should be transplanted into lines in the open ground, which transplanting tends greatly to encourage fibrous roots, and therefore to secure success in after transplanting. From this disposition of the plant to run to tap-root and not to fibrous roots, the plants should never be allowed to remain longer in the nursery than two years from the time of their coming above ground, as if they should be kept longer they will not transplant so safely afterwards.

857. In England this tree often attains the height of from 70 to 80 feet, with stems from 2 to 3 feet in diameter. At Longleat there is a specimen about 100 feet high, with a stem 12 feet circumference at 4 feet from the ground. In Scotland there are specimens from 60 to 70 feet high, with stems from 2 to 3 feet in diameter.

SECTION XVII.—THE HORNBEAM (CARPINUS)—LINNÆAN SYSTEM, MONŒCIA POLYANDRIA.

858. *Character of the genus.*—Barren flower in a cylindrical catkin; its scales roundish, ciliated at the base. Stamens 8-20. Fertile flower in a lax catkin, its scales large, foliaceous, 3-lobed, 1-flowered. Involucre, none. Perianth of 1-leaf, urceolate, 6-dentate, incorporated with the 2-celled germen, of which 1 cell is abortive. Styles 2; nut ovate, striated, 1-seeded.

859. We shall refer only to one species of this genus—namely, the *C. Betulus*, or common hornbeam, as it is the chief timber-tree of the family, is very hardy, and attains to very considerable magnitude of timber under favourable circumstances.

CARPINUS BETULUS, or Common Hornbeam.

860. *Specific character.*—Scales or bracteas of the fruit oblong, serrated, with two smaller lateral lobes.

861. *Geography.*—The common hornbeam is a native of all parts of central Europe, being found in France, Germany, Italy, the south of Russia, and in the west of Asia. It is also a native of England, Ireland, and the southern parts of Scotland.

862. *Description of tree.*—It is a singular fact in the history of the arboriculture of this country, that although the hornbeam, when grown on a good loamy soil, often attains a diameter of stem from 2 to 3 feet, or even more, with a height of some 60 to 70 feet; and although, under such circumstances, it is a very ornamental and dense-headed spreading tree,—it has not been much cultivated, but rather neglected, and reduced to the position of a mere hedge plant. This may have arisen from the great tendency that the tree has to become branchy and short of stem, and thus not much worth as timber; and hence its general fitness for hedging purposes. It is, notwithstanding, a tree capable of being cultivated to very considerable timber size, as we have frequently seen good specimens of it grown in plantations among other trees, where it had its tendency to throw out branches checked by standing among them. In fact, this tree is so seldom seen of timber size that we have known practical foresters of long experience who did not know it when they had one pointed out to them, and who conceived it to be a species of beech. It certainly does much resemble the common beech, but it is easily distinguished from it by the *feather-nerved* and *plaited* appearance of the leaves (see fig. 107), as well as by the appearance of the seed or nuts, which have a flat, leafy, three-lobed appendage (see fig. 108). The

plant is chiefly reared for hedging purposes; and as it stands pruning well, it answers for this purpose admirably.

Fig. 107.

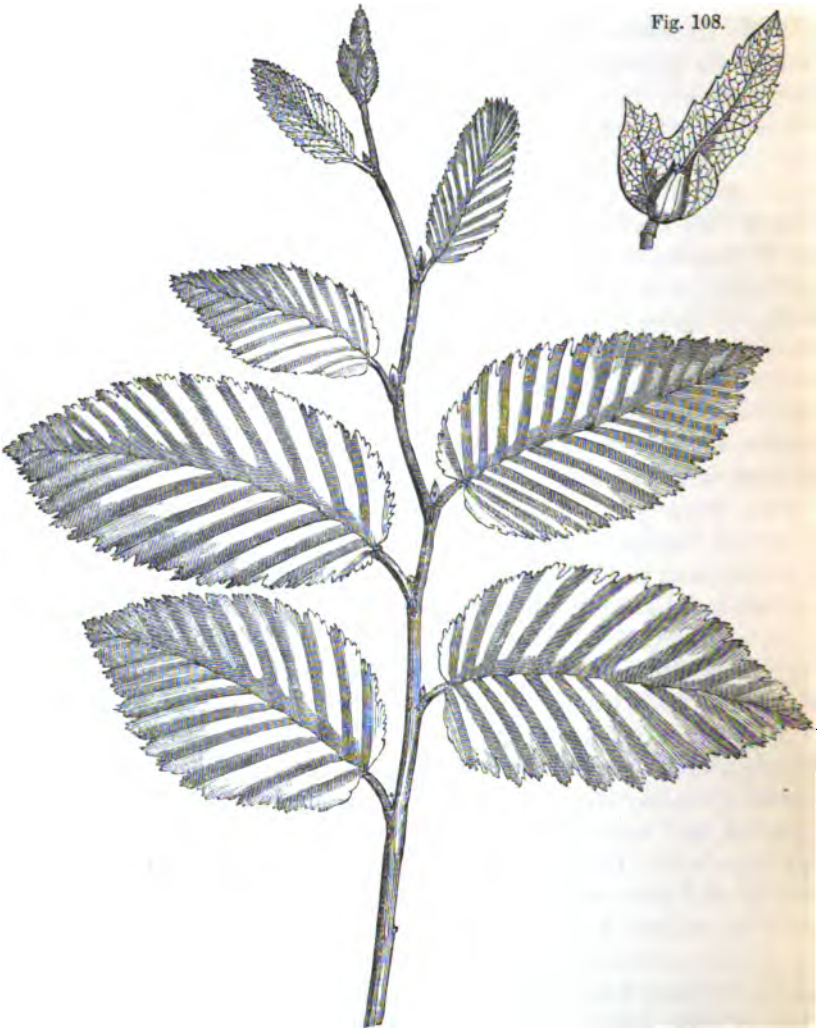


Fig. 108.

863. *Economic uses of timber.*—The wood of the hornbeam is white, and of a very hard texture, and heavy compared with many other kinds of timber, and is withal a very cross-grained kind of wood, and difficult to work in the hands of the tradesman. It is, however, often used by country carpenters for many of the rural purposes to which the timber of the beech is applied. It makes excellent firewood, and we have ourselves made considerable quanti-

ties of charcoal from it. Indeed it is seldom that the tree is found of sufficient timber dimensions to make it valuable in this country, the greater portion of the trees that we have had occasion to fell of it being comparatively small, and only fit for firewood and charcoal.

864. *Soil and situation.*—As a hedge plant, the hornbeam will thrive on most soils, excepting those of a chalky nature. As a timber-tree, however, it attains its largest dimensions on lands of a stiff and rather clayey nature.

865. *Propagation and culture.*—The seed does not generally ripen in Scotland, but in England it does readily. It should be sown when gathered, in the month of October, as the greater part of it generally requires to lie one year in the ground before vegetating. The plants should be planted out into nursery-lines when one year old, and allowed to stand for two years before being put out to their permanent sites.

866. On many places in England this species is found 70 feet high, with stems from 30 to 36 inches diameter. In Scotland we have found it frequently from 50 to 60 feet high, with stems over 30 inches in diameter.

SECTION XVIII.—THE CHERRY (PRUNUS)—LINNÆAN SYSTEM, ICOSANDRIA MONOGYNIA.

867. *Character of the genus.*—Calyx 5-cleft; petals 5. Drupe with a hard smooth nut.

868. As almost all the species of this genus are cultivated chiefly either for their fruit or for ornamental purposes, and as only one of them is considered worthy of being planted as a timber-tree—namely, the *P. avium*, or the wild black-fruited cherry-tree, or gean—we shall not refer to any of them but it.

PRUNUS AVIUM, Common Wild Cherry or Gean.

869. *Specific character.*—Umbel sessile, leaves ovate-lanceolate, pubescent beneath, folded together.

870. *Geography.*—This species is a native of most parts of Europe, and is found in the wild state in many woods in Britain.

871. *Description of tree.*—This tree is well known in most parts of Britain, being very often found wild in our woods, and in old hedges, in both of which it has a good effect in the spring when in flower, in summer when in fruit, and in autumn when the leaves become of a reddish-yellow colour. It is well deserving of a place in any plantation where ornament is an object, especially by the sides of roads

running through it, as it comes early into flower, and gives an enlivening effect to woods at a season when most other trees are only beginning to unfold their buds.

872. *Economic uses of timber.*—The timber of the wild cherry is much sought after by cabinetmakers for furniture, and we have always found a good tree of it sell at a high price for this purpose, as it is seldom that a tree of any size is brought into market.

873. *Soil and situation.*—The tree will grow well on any moderately good soil if dry, and grows rapidly without almost any attention. It makes its largest bulk of timber, however, on a good, deep, rich, and rather light loam: on soils of this kind we have seen trees of it felled upwards of 45 feet in height, and containing a considerable quantity of useful timber.

874. *Propagation and culture.*—This tree is propagated from the seed or stone, so well known to every one that it requires no description here. They generally ripen in July, and should be sown shortly afterwards, as they are very apt to lose their vitality if long kept. Most of the other species and varieties of the cherry which are cultivated in gardens for their fruit are propagated by grafting on young stocks of this tree, raised from seeds.

SECTION XIX.—THE HAWTHORN (CRATÆGUS)—LINNÆAN SYSTEM, ICOSANDRIA DIPENTAGYNIA.

875. *Character of the genus.*—Calyx 5-toothed; petals spreading, orbicular. Ovary 2-5 celled; styles smooth; apple fleshy, oblong, closed by the teeth of the calyx, or by the thickened disc. Putamen bony.

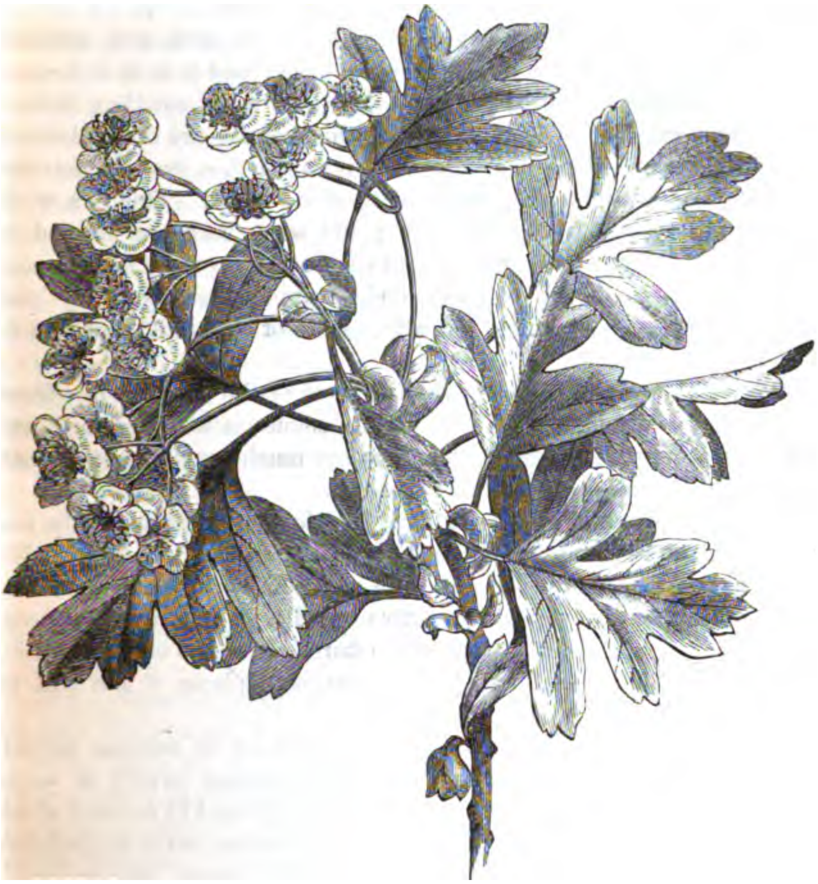
876. There are many species and varieties of the genus, chiefly deciduous small trees or large shrubs, and a few of them only attain the height of 30 feet. The greater number of the species are natives of North America and Europe, and all are free growers, profuse flowerers, and very ornamental. In a work of this kind, which professes to treat of timber-trees only, we shall not refer to any of the members of this family but one—namely, the *C. oxyacantha*, or common hawthorn, which is not only well known, and useful for hedging purposes, but also for its ornamental effect, both in summer when in flower, and in autumn and winter when in fruit.

CRATÆGUS OXYACANTHA, or Common Hawthorn.

877. *Specific character.*—Leaves obtuse, subtrifid, serrated, smooth; peduncle and calyx nearly smooth; sepals lanceolate, acute (see fig. 109).

878. *Geography.*—The common hawthorn is found in most parts of Europe, and in the west of Asia and north of Africa, It is found nearly all over Britain in the cultivated state, and often growing wild in woods and neglected fields.

Fig. 109.



879. *Description of tree.*—The thorn-plant cannot, properly speaking, be considered in the light of a timber-tree, although, as is often to be observed, it may, by cultivation and attention to judicious pruning, be made to attain very considerable dimensions; still in this respect it holds but a low rank, and must be considered merely as an ornamental bush, capable of being trained to the size of a small tree.

The great use of the thorn in this country is that of hedging, and for this purpose we have no other plant so suitable, not only from its being adapted to grow in a great variety of soils, but from its firmness of habit and strength to resist pressure, when properly trained for the purpose. In the wild state, the thorn, when found in a loamy soil with a dry bottom, grows very freely and rapidly when under 15 years of age; but as it attains the height of from 15 to 20 feet, it grows more to breadth of top than to height of stem, and assumes the character of a large and spreading bush; and it is in this state that it is so much admired for its profusion of sweet-smelling flowers and bright-red fruit. The flowers of this species are of a pinkish-white colour, and there is a variety of it called *C. o. rosea*, which has the petals of a bright-pink colour, with white claws. This is a well-known variety, and is very beautiful; and when both are planted in the same neighbourhood, and near to each other, so as to form a contrast, the effect is very pleasing, and is appreciated by every one, especially when in combination with plants of different shadings in the background.

880. *Economic uses of timber.*—The wood of the common hawthorn is very hard. It is of a yellowish-white colour, is finely grained, and takes on a very pretty polish, but it is not much sought after for any purpose. It makes an excellent firewood.

881. *Soil and situation.*—To have the thorn to grow healthily and well, it must be planted on a good, dry, and rather rich loam. We have never seen it growing well on a wet soil, nor on one poor and light, but have always seen it thrive rapidly on a heavy dry loam, even although somewhat of a clayey nature. It is one of our hardiest plants, and will succeed well on even exposed places if the soil on which it is planted is dry and suitable.

882. *Propagation and culture.*—The hawthorn in seasons favourable for fruit generally bears a great and abundant supply of seeds, which are termed *haws:* these are ordinarily ripe and fit for seed about the beginning of November. They should, however, never be gathered for seed until they are perfectly ripe, and this state may be easily known by their being of a dark-red colour, mealy, and the fleshy fruit separating freely from the stone. If gathered before they are ripe, the cotyledons of the seed are liable to perish from not having been perfected before gathering. The haws should be pulled from the bushes by the hand. When gathered for the purpose of raising plants from them, they should be laid in a heap, in which to rot the pulp, and to separate it from the stones. This is best done by laying them in a ridge form in the open air, and upon the ground, say 24 inches high in the middle and 48 inches broad at bottom; or the ridge may be of smaller dimensions if a small quantity is wanted. To prevent the pulp part of the fruit from heating, and thereby endangering the vitality of the seed, our plan is to mix them with

finely riddled soil, say in quantity equal to the bulk of the seed or haws themselves. The whole should be intimately mixed together, so as to hasten the decomposition of the pulp, and should be turned over now and then, say once in the two weeks, so as to turn inwards the portion which lay most exposed to the air, and outward the portion which was innermost. In this rot-heap we allow the haws to lie for fifteen or sixteen months, when the pulp will be perfectly rotted, and the seed ready for sowing. Then, supposing that the haws were gathered and put into a rot-heap in November 1880, they will be ready for sowing in February 1882. They should be sown in beds on a good light mould properly prepared for the purpose. They should not be sown thickly but rather thinly, say at the rate of one seed to the square inch, and they should be covered with nearly half an inch of earth. They will *braird* the same year, but should not be lifted till they have stood two years in the seed-bed. When at this stage they should be planted into lines in the nursery, say 2 inches plant from plant, and the lines 12 inches apart. When they have stood two years in this state, or when they are four years old, they will be quite fit for hedging or other purposes.

The varieties are extended by budding or grafting on the stocks of the common hawthorn.

SECTION XX.—THE HOLLY (ILEX)—LINNÆAN SYSTEM, TETRANDRIA TETRAGYNIA.

883. *Character of the genus.*—Calyx 4-5 toothed; corolla 4-5 cleft, rotate. Style none. Berry 4-seeded.

884. There are several species and varieties of this genus, some of them with spiny teeth on their leaves and others without, mostly evergreens, and low trees or shrubs, natives chiefly of Britain and North America. The only species, however, that we shall refer to, is the prickly-leaved or common holly (*Ilex aquifolium*).

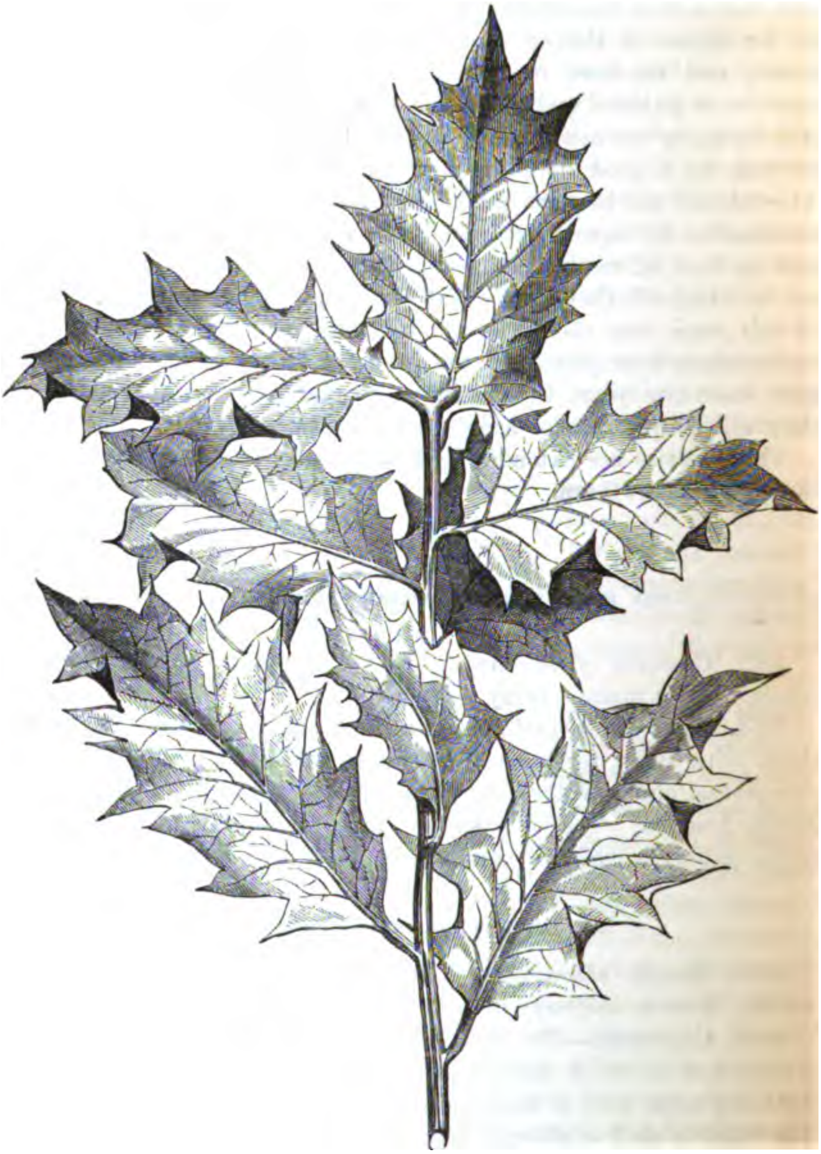
ILEX AQUIFOLIUM, or Common Holly.

885. *Specific character.* — Leaves ovate, acute, spiny, shining waved; flowers axillary, umbelled (see fig. 110).

886. *Geography.*—The holly is a native of most parts of the middle and south of Europe; found in woods and shady places, in light dry soils, with a large proportion of vegetable matter in them. The plant is said to abound largely in many of the German forests, particularly in those of the southern and middle states. In England the plant is plentifully distributed in natural woods, especially in the districts of New Forest in Hampshire, and Dean Forest in Gloucester-

shire; and we have found it plentiful in many parts of Scotland—as, for example, in the natural woods on the north side of Loch Ness, belonging to Lord Seafield.

Fig. 110.



887. *Description of tree.*—This is a plant the size of which depends very much upon whether it grows in a cultivated or in a wild

state. In the wild state we have seldom seen it more than 20 feet high, while in the cultivated state we have seen it upwards of 60 feet, with very respectable bulk of timber in its stem. This plant, however, is not cultivated for its timber, but almost exclusively for its ornamental effect, which is beautiful at all seasons of the year, from its being evergreen, and from its enlivening effect in winter when clothed with its clustering berries.

888. *Economic uses of timber.*—When an old tree of some size is cut down, it is very readily sold at a good rate to cabinetmakers for furniture, and to many other tradesmen for various purposes, and among others to turners and engineers.

889. *Soil and situation.*—The soil in which we have seen the best specimens of this plant is a light loam, with a good deal of vegetable matter in it, and dry. We have indeed seen fair plants of the common holly, both green and variegated leaved, in soil of a heavy and in that of a poor character; but we do not remember of ever seeing really healthy or well-grown specimens in a soil that did not contain a large percentage of decayed vegetable matter, such as is generally found in very old woodlands.

We have already, in a former section, referred to the use of this plant for hedging, for which purpose few plants are better fitted, as it forms both an impregnable fence and an evergreen,—one pleasant from the shelter it affords, and from its appearance at all times. Although the holly is very hardy, and will grow to a good size on poor and exposed sites, still, to have it in perfection, it should be planted in rather a sheltered part, where it has the protection of larger trees to shield it from storm. It grows well even under the shade of other trees.

890. *Propagation and culture.*—This holly is always propagated from seed, but the several varieties of it are so by budding and grafting, and sometimes by cuttings. Our mode of gathering and preparing the seed, as well as that of sowing it, is in all respects the same as that already described in regard to the rearing of the hawthorn. The seeds of both require about two years to come up, therefore the use of land is saved one year by preparing them one year previously; that is, if the seed of these (the thorn and the holly) were sown when gathered, it would lie nearly two years in the ground before it came up, but when rotted as described, and not sown for sixteen months after gathering, it will come up the same year in which it is sown. The holly is of slow growth at all its stages, and from this it will be found advisable to let the plants stand three years in the nursery-lines before planting them out into their permanent sites, as by this mode they become well fibred in their roots, and strong—which is necessary in order to insure success in their cul-

tivation. When the plants are wanted of a large size before putting them out, they should be twice transplanted, and allowed to stand four or five years in the nursery-lines, taking care to give them room to develop themselves, and not to confine them in their young stages.

As hollies, even in their young state—say, when of the age of 2-year seedlings, and just when they should be removed from the seed-bed into the nursery-rows—are impatient of removal if the weather be at all dry, care should be taken to transplant them only in wet weather. Our own plan is to remove them from the seed-bed to the lines in wet weather about the end of April; and although the weather should be pretty wet, we invariably give the roots a thorough watering, after the first spadeful of earth is put on them. This secures the safe removal of the plants; otherwise many would certainly die.

SECTION XXI.—THE MOUNTAIN-ASH (PYRUS AUCUPARIA)—LINNÆAN SYSTEM, ICOSANDRIA DIPENTAGYNIA.

891. *Character of the genus Pyrus.*—Calyx 5-toothed. Petals roundish. Apple closed, 5-celled, with a cartilaginous putamen. Cells 2-seeded. Testa cartilaginous.

892. The genus *Pyrus* comprehends the most popular of our British fruits—namely, pears and apples; but the only species of it to which we shall refer here is that named at the head of this section, which is a handsome small tree in our woods at all seasons of the year, and one which is well known to every native of Britain by the names of the *rowan-tree* in Scotland and the *witchen-tree* in England.

PYRUS AUCUPARIA, or Common Mountain-Ash.

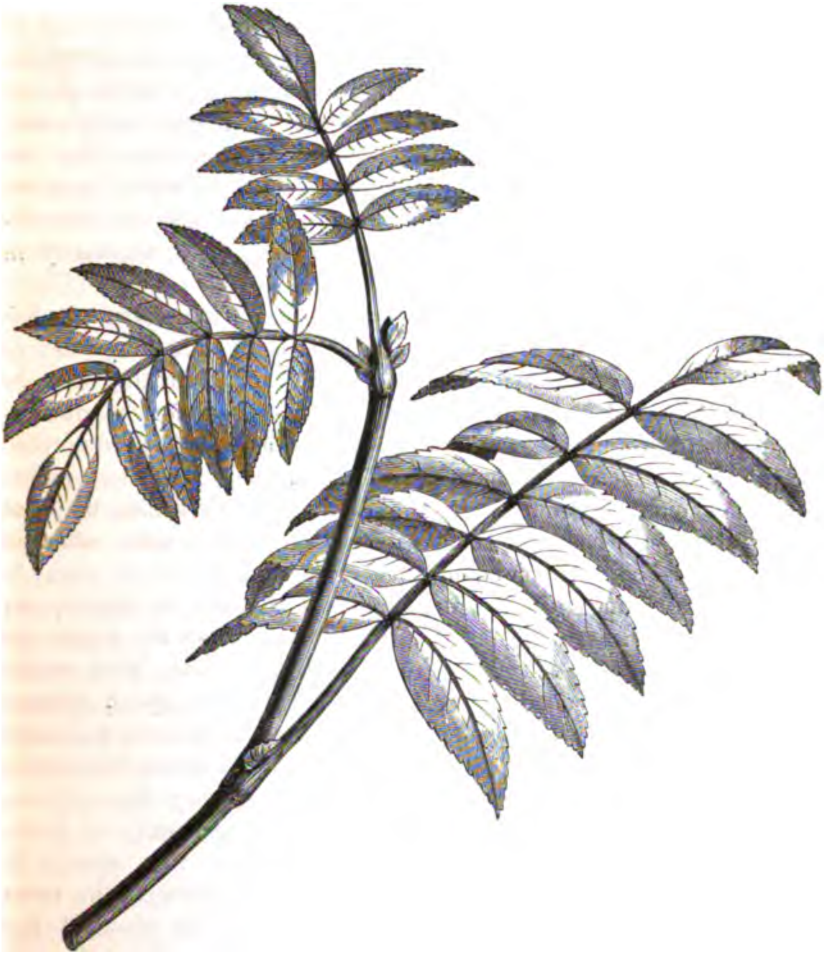
893. *Specific character.*—Leaves pinnated, smooth on both sides; pomes globose (see fig. 111).

894. *Geography.*—The common mountain-ash is a native of most parts of Europe, from Iceland on the north to the Mediterranean on the south; and is said to be found also in the north-west of Asia and in the northern parts of North America. In Britain it is found common in our woods and hedges all over the country, and generally on moist cold-bottomed lands.

895. *Description of tree.*—The mountain-ash, *rowan-tree*, or *witchen-tree*, is too well known to require any particular description here. Suffice it to say that it is readily distinguished from all the other species of the same genus by its beautifully *pinnate* or winged leaves, (see fig. 111), which very much resemble those of the common ash,

and also by its bright-red bunches of berries, which are generally ripe, and give the tree a fine effect, about the 1st of October, when the birds begin to feed on them. It may perhaps not be worthy of being classed as a timber-tree; still, in this respect it attains, on good land, respectable dimensions, frequently 30 feet high, with a stem of about 2 feet diameter. We do not, however, mean to say that this tree is worthy of being grown for the sake of its timber, but for its protection as a nurse to hard-wooded sorts on certain parts where the pine and the larch would be apt to overgrow and spoil them. We have found this tree an admirable nurse for hard-woods in small plantations or narrow beltings, as it never overtops other trees growing with it, but admits, from its upright habit, perfect

Fig. 111.



freedom of growth for their branches. It is, besides, excellently adapted for growing as a coppice, as, from its quick habit of growth when young, it makes strong shoots within the first four or five years after being cut down, which are found to suit well for hoops, and for all sorts of crates and rough basket-work.

896. *Soil and situation.*—This tree will grow well on very poor soils, and on the most exposed situations; but where it is wanted as ornamental specimens it should be grown on a good soil, somewhat sheltered, but not confined. The proper situation for the mountain-ash is on the sides of roads in plantations, where it grows rapidly, and soon attains a fair size of top, and becomes an interesting object among both deciduous and evergreen trees, especially in the autumn, when its fruit is in perfection.

897. *Propagation and culture.*—The seed of the mountain-ash should be gathered as soon as it is ripe, as birds are very fond of it, and congregate where it is, and soon devour it if the crop be not very plentiful. After it is gathered, the seed for a crop of young plants should be dealt with exactly as has been described for the preparation of the hawthorn-seed. The seed of these plants lies about eighteen months in the earth before it comes up; but when rotted in a heap for some fifteen months, and sown after all the pulp has been decomposed, they come up in June if sown in the previous spring. In sowing, it should be scattered thinly, say 1 seed to 2 inches square, as the leaves, even when the plants are young, are comparatively large, and if thickly sown, they would be drawn up and spoiled by crowding. The mountain-ash being a rapid-growing plant when young, it should not be kept in the seed-bed longer than one year. The plants should therefore be planted out into the nursery-lines the first winter after they have sprung up in the seed-beds, and at this stage they will generally be found from 8 to 12 inches high. In the nursery-lines they should be put in 3 inches plant from plant, and 18 inches betwixt the rows. When they stand one year in the lines, they will be about 3 feet high on the average, and fit for planting out.

SECTION XXII.—THE CYTISUS—LINNÆAN SYSTEM, DIADELPHIA DECANDRIA.

898. *Character of genus.*—Calyx 2-labiate, 2-3 legume, attenuated at base.

899. This is a genus of ornamental trees and shrubs, of which the species called Laburnums are well-known and greatly admired examples, and to them only will we refer here, as they are admirably adapted for ornamenting the sides of roads in our woods, and are

perfectly hardy. There are two species of laburnum—namely, the *Cytisus laburnum*, or common laburnum, and the *C. alpinus*, or Scots laburnum, which are so much alike as to be generally confounded together. They are quite distinct, however, the latter species flowering much later in the season than the former, and having the pods quite smooth, while those of the other are hairy. In describing them, however, we shall embrace them as one, as, with the exception of the differences stated, they have the same appearance, and are propagated and cultivated in precisely the same way, are of the same habit, and equally showy and hardy.

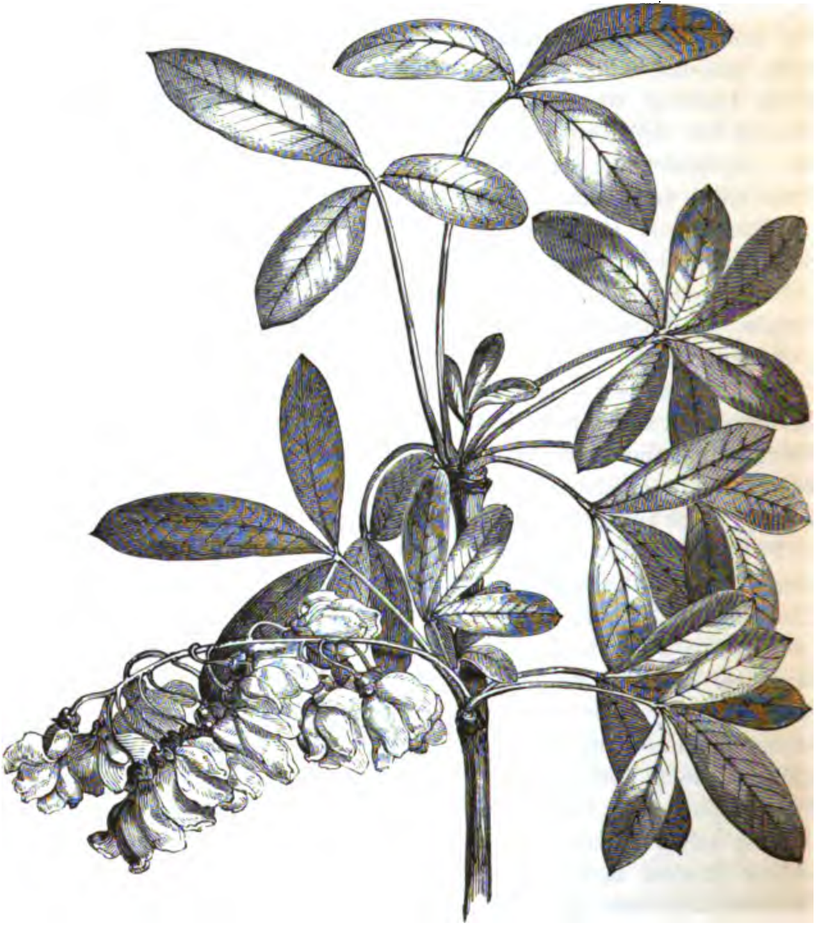
900. *Specific characters of the two laburnums.*—*Cytisus laburnum*, or common laburnum—Racemes simple, pendulous; leaflets ovate, oblong; pods hairy. *Cytisus alpinus*, or Scots laburnum—Racemes simple, pendulous; leaflets ovate, oblong, rounded at base; pods quite smooth.

901. *Geography.*—The laburnum is said to grow spontaneously in forests in the mountainous parts of Germany, Austria, Hungary, Switzerland, and Italy, and even in France; but although it has been long in cultivation in Britain—since about 1600—it cannot be said to be indigenous to this country.

902. *Description of tree.*—The laburnum may not, perhaps, be considered in the light of a timber-tree, as it seldom attains large dimensions of stem: still, when left alone unencumbered, and when growing on a dry and good loamy soil, it does frequently attain a fair size. But laying out of view altogether any recommendations this tree may have as regards its timber, it has the greatest claim to our favour on account of its very highly ornamental effect. We know of no flowering-tree which is more worthy of being cultivated for this purpose. In the months of June and July its bright-green shining foliage, mixed up with its pendulous branches of brilliant yellow flowers, is, in our estimation, the perfection of beauty of a flowering-tree (see fig. 112). And it is so graceful withal,—notwithstanding its very showy exhibition of leaf and flower, it is of a modest and unassuming deportment. The general outline of the whole plant is irregular and natural, and this characteristic adds much to its beauty and effect. What makes this tree so very showy in its flowering season is the smallness of its leaves compared with the size of its bunches of flowers. The leaves are small, and only three on a petiole, while the flowers are numerous on one stalk, and hanging each like a bunch of yellow grapes.

The laburnum is worthy of a place in any collection of ornamental trees, but its proper place is on the sides of roads and walks, whether in the park, the shrubbery, or the woods, where it always forms a most agreeable object when allowed full space for the development of its head and branches,—for without a large head the tree does not form so ornamental an object as it is capable of doing.

Fig. 112.



903. *Economic uses of timber.*—The timber of the laburnum, when of good size — say a stem from 12 to 20 inches diameter — is very valuable for furniture purposes. We have ourselves sold it at 7s. per cubic foot. It is much sought after by cabinetmakers.

904. *Soil and situation.*—The laburnum will grow in most soils; but to grow it well and to a large size, it requires a deep, loamy, and rather light soil, and dry, and a situation well sheltered among other trees. When planted for timber it should be on a strong soil, but if for ornament it may be planted on any part wanted. It continues longest in flower when shaded by other trees from the direct rays of the sun.

905. *Propagation and culture*—The seed of this tree is generally ripe about the middle of October, when the seed-pods should be gathered for sowing. When collected they should be stored in an airy loft and kept dry till they are required for sowing, which is about the end of March. They may be sown in any light soil, in beds, but thinly, and covered to the depth of half an inch. As the laburnum is a rapid-growing plant when young, the plants should be lifted from the seed-bed the following spring, and planted out into lines in the nursery-ground, as directed in reference to the mountain-ash.

SECTION XXIII.—THE ROBINIA—LINNÆAN SYSTEM, DIADELPHIA DECANDRIA.

906. *Character of the genus.*—Calyx 4-fid; upper segment 2-parted. Legume gibbous, long. Leaves unequally pinnate.

907. We shall refer only to one species of this genus—namely, the *Robinia pseudacacia*, the common robinia, or false acacia, as it is a rapid-growing tree, with beautiful, fine, pinnated leaves, and pendulous, white, sweet-smelling flowers, making it in all respects a desirable tree for ornamenting lawns and shrubberies.

ROBINIA PSEUDACACIA, or False Acacia.

908. *Specific character.*—Racemes with 1-fl. pedicels; leaves pinnated, with an odd one; stipules spiny; pods smooth.

909. *Geography.*—This tree is a native of North America, and we have found it in the natural forests of Canada, and also in those of the Northern States of the Union. It is not found in masses together in these forests, but generally only as an individual mixed with other trees, or in small groups, and always on dry good land. It is a tree much cultivated by the American people, both on account of the great durability of its timber and its ornamental effect. In most of the older settled districts, especially in Upper Canada and in the States of New York and Pennsylvania, the farmers have this tree, which they call the locust-tree, planted about their gardens and home-parks; and frequently we have seen very old specimens standing in fields which had evidently been left from the original forest when the settler cleared it. This tree is perfectly hardy in most parts of Britain—in the better parts of the country attaining considerable size, and forming fine ornamental trees, giving a peculiar effect to the landscape by their beautiful pinnated leaves and pendulous bunches of pinkish white flowers.

910. *Description of tree.*—The value of this tree is not sufficiently

known in Britain, whether as an ornamental or a timber one, and we therefore here recommend it to landed proprietors as worthy of more attention than has been hitherto bestowed on it. We do not mean to recommend it as a timber-tree; for although its timber is of the most durable description, and is highly prized for many purposes in America, still we have many other trees which with us are more profitable for timber. We recommend it chiefly as an ornamental one, to be planted on our lawns, on the edges of plantations, and on the sides of roads leading through woods, where its graceful foliage is calculated to produce variety among the leaves of our commoner trees, and where its racemes of beautiful flowers produce a charm quite unknown to those who are accustomed to look on trees as objects generally without flowers.

In its native woods we have found the *Robinia pseudacacia* frequently from 70 to 80 feet high, with a trunk upwards of 2 feet in diameter at the part at which we could measure it while standing; but the tree attained this height only when growing in a crowded state among walnuts, lime-trees, and maple. On the sides of rivers and lakes, where it had open space to throw out its branches, we have generally found it only from 30 to 40 feet high, with a short irregularly shaped stem, which was generally of 3 feet diameter; and in this state it forms a highly ornamental tree, presenting a broad mass of light-green airy-looking foliage, intermixed with large bunches of pendulous flowers. It is in the latter state that the tree should be cultivated in Britain—that is, it should not be planted intermixed with other trees in a plantation, as in this case its natural beauties would be lost, but on a lawn, or on the sides of roads in plantations, where it may have ample space to develop its limbs and branches all round, and present a full and corresponding mass of leaf and flower.

The tree grows rapidly upwards in its younger stages, but as it grows old the branches spread out horizontally, and very little growth is made upwards, in this respect resembling the mountain-ash and laburnums. The branches of young trees are armed with strong hooked prickles, but these are not found on old trees. The leaves are pinnated, and of a very fine and thin texture. It is an excellent tree for growing on the sides of streets in towns, and in that position gives an agreeable effect in summer. It is largely planted on the sides of the streets in the city of Montreal, in Canada.

911. *Economic uses of timber.*—The wood of this tree is very heavy and hard when matured, and is found to be very durable for all kinds of purposes, whether outdoor or indoor. It is even said to be a stronger and more durable wood than the British oak. In America the wood is used for fencing and other outdoor purposes; and there it is also much used in house-building and for furniture-making. In

short, in all parts of America where the tree is found, it is much sought after for the purposes stated; but it is not so plentiful anywhere as to be commonly used for many purposes in any one locality.

912. *Soil and situation.*—In the American woods we have found this tree for the most part growing on deep light lands, always dry, and of a moderately rich character. In this country, however, we find the *Robinia pseudacacia* often growing well on very poor lands; and even in Canada, especially in the neighbourhood of the city of Ottawa, we have found it on poor sandy land, growing luxuriantly where the land had been so much exhausted as to be unfit for the profitable cultivation of farm crops. With regard to soil, the tree grows well on most soils not wet, nor of a heavy nature; and as to situation, it should be always sheltered, but not confined, as the tree will not prosper if it have not an airy site, freely exposed to the rays of the sun, nor will it under any other circumstances develop itself so as to take on its proper character—namely, that of a broad-topped tree, clothed with branches down to the ground.

913. *Propagation and culture.*—The seed of this tree ripens well in England, and sometimes in Scotland; but nurserymen generally procure their supply of it from America direct. Whether it be got from trees grown in the country or from America, it should always be preserved in the pods till sown, as if not, it is very apt to lose its vitality, and in consequence much of it would fail to grow. The seeds got from America are much surer to vegetate than those gathered from home-grown trees, and are therefore to be preferred. They should be sown early in spring—say, during good weather, in the end of February or beginning of March—and in rows 15 inches apart. The soil should be light and rich, and well prepared, and the covering may be fully half an inch. The seeds should not be sown closer than one to every 3 inches square. The plants will come up during the following summer, and be fit for transplanting out into nursery-rows the spring after. In the nursery-rows they should be planted 4 inches plant from plant, and the distance between the rows should not be less than 20 inches. When they have stood one year in the lines they will be about 3 feet high, and ready to plant out into their permanent sites; and no tree transplants more securely.

CHAPTER IX.

SECTION I. — THE CONIFEROUS KINDS OF TREES USUALLY PLANTED IN THIS COUNTRY, TOGETHER WITH SUCH OF THE NEWER KINDS OF CONIFERS AS ARE SUFFICIENTLY HARDY FOR, AND WORTH CULTIVATION IN, GREAT BRITAIN AND IRELAND.

914. These may be stated as under:—

Two leaves in a sheath.

Pinus sylvestris.
„ austriaca.
„ pinaster.
„ resinosa.
„ pyrenaica.
„ Mugho.
„ laricio.
„ pumilio.

Pinus inops.
„ muricata.
„ Pallasiana.
„ persica.
„ pinea.
„ halepensis.
„ Brutia.

Three leaves in a sheath.

Pinus Gerardiana.
„ macrocarpa.
„ Bungeana.
„ ponderosa.
„ Benthamiana.
„ rigida.

Pinus radiata.
„ insignis.
„ Sabiniana.
„ Jeffreyii.
„ tuberculata.

Five leaves in a sheath.

Pinus cembra.
„ excelsa.
„ Lambertiana.
„ Monticola.

Pinus Montezumæ.
„ strobus.
„ Hartwegii.

Abies excelsa.
„ canadensis.
„ nigra.
„ alba.
„ Albertiana.
„ Douglasii.
„ Menziesii.
„ Smithiana.

Abies orientalis.
„ Pattoniana.
„ Alcoquiana.
„ rubra.
Picea pectinata.
„ balsamea.
„ amabilis.
„ bracteata.

Picea grandis.
„ cephalonica.
„ Lowiana.
„ nobilis.
„ Nordmanniana.
„ Pindrow.
„ pinsapo.
„ Webbiana.
Larix europea.
Cedrus Libani.
„ Deodara.
„ atlantica.
Taxus baccata.
Cupressus Lawsoniana.
Cupressus sempervirens.
„ macrocarpa.
„ nutkaensis.
Thuja gigantea.
„ occidentalis.
Libocedrus decurrens.
Juniperus virginiana.
Cryptomeria japonica.
„ elegans.
Sequoia gigantea.
„ sempervirens.
Araucaria imbricata.
Biota orientalis.
Retinospora obtusa.

915. As this work professes to treat only of such trees as are known and proved to be worthy of cultivation in our forests, plantations, and parks, we have, in the foregoing list, named only such of the species of each genus embraced as we have found from our own experience hardy enough for our climate, and suited for being reared, either to useful timber size or to give ornamental effect. We have found the greater part of them quite hardy enough for the climate of the better parts of Scotland, and all of them perfectly hardy and in all respects suited to become useful and ornamental trees in the southern and middle parts of Britain—as, indeed, many of them have already become; keeping out of view altogether the kinds usually cultivated in our plantations for their timber. We have therefore no hesitation in stating, that all the kinds named in the foregoing list are adapted to grow well in our climate, and to become useful, either as timber or as ornamental trees; and having made these remarks, we purpose next to devote a separate section to the description of each of the kinds named, beginning with the first in order.

SECTION II.—THE PINE (PINUS)—LINNÆAN SYSTEM, MONŒCIA MONADELPHIA.

916. *Character of the genus.*—Male flowers in grouped catkins, placed in dense masses around the shoots; the female one solitary, or in whorls, and terminal. Cones more or less conical, and woody. Scales numerous, persistent, more or less elevated, pyramidal, swollen, and imbricated. Seeds oval, with a hard bony shell, and either furnished with ample wings or wingless. Seed-leaves numerous. Leaves simple, awl-shaped, and entire, evergreen and rigid, sheathed, and generally in groups of two, three, or five, each group arising out of a scaly sheath.

917. The pines are all evergreen trees, for the most part of large

size, and natives of the hilly regions of Europe, America, and Asia; and they are, in respect to economical purposes, perhaps the most useful of all trees to mankind. Nearly all the species flower in Britain in the months of May and June, and generally ripen their cones in the autumn of the following year. They all require a light, porous, dry land to prosper in, and none of them grow healthy unless they live in a pure state of air, such as is always found on elevated sites, and at a considerable distance from the smoke of towns. They are all impatient of wetness in the soil, and do not succeed on a heavy land retaining much moisture; and they in all cases are found to develop themselves more healthily, and to live to a greater age, on a soil that is rather poor than rich; and, moreover, most of those species which have been introduced from America and Asia prosper better in Britain when planted on sites having aspects between the south-west and north, than they do on sites having aspects opposite to those.

SECTION III.—PINUS SYLVESTRIS, OR SCOTS PINE.

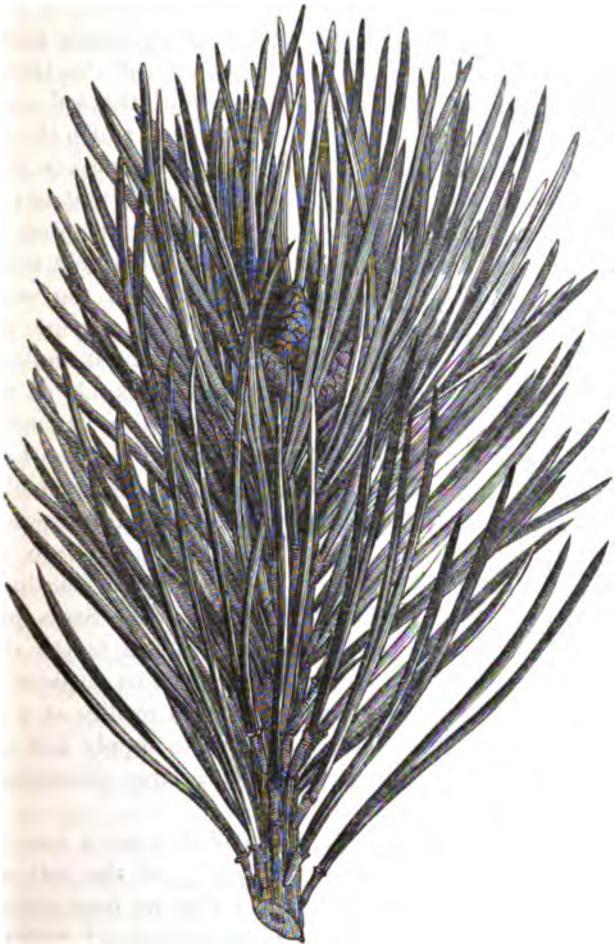
918. *Specific character.*—Leaves in pairs, rigid. Cones conico-ovate, acute, as long as the leaves, generally in pairs.

919. *Geography.*—This is the only one of the pine tribe which can be said to be a native of Britain; and in so far as regards the usefulness of the tree, it is at least inferior to no other species which has yet been introduced. It becomes a tree of first-rate magnitude in favourable situations, and is one of the most hardy of our forest-trees, being found in Scotland growing fully 2000 feet above the level of the sea. At one time this tree must have been very plentiful in the Highlands of Scotland, and, no doubt, in many parts of the Lowlands, as is evident from the remains of trees yet growing. We may mention, in particular, the remains of the natural pine-forests still existing about Invercauld, Rothiemurchus, Glenmore, Abernethy, and Duthal, where there are by far the finest specimens of the Scots pine to be found in Britain. Although we give this tree the name of the Scots pine, it is by no means confined to this country: it is found growing naturally in most of the countries in the north of Europe and Asia, but, we believe, has not been found in America. It abounds very plentifully in the north of Germany, Sweden, and Norway; and from these countries we are in the habit of importing it under the name of *red pine timber*, which is reckoned the best quality of pine timber imported from those countries.

920. *Description of tree.*—This species is easily recognised from any of the introduced ones by its buds, leaves, and cones. The buds are what are called *ovate*, *blunt*, and *pointed*, and around the central

one there are generally from four to six smaller ones set close round it (see fig. 113). In healthy grown trees the leaves are generally from

Fig. 113.



2½ to 3½ inches in length, slightly twisted in their length, somewhat concave on the upper surface, and convex on the under. Their colour varies from bluish green to dark green, and they are very finely serrulated on the edges. The cones are from 2 to 2½ inches long, and about 1 inch across at the broadest part. They are generally in pairs, and recurved, and when ripe are of a reddish-brown colour.

In the natural forests yet remaining in Scotland there are found trees of the Scots pine which have attained large dimensions. We have measured some of them ourselves, which were from 12 to 13 feet in circumference of stem, near the ground, and about 80 feet high, many of them being between 300 and 400 years old. When the Scots pine is full grown and somewhat old, there are few trees more picturesque. The stem is generally straight and clear of branches for a considerable way up, and has its bark of a reddish colour, comparatively smooth, but scaling off, and generally deeply furrowed.

921. *Economic uses of timber.*—The quality of the timber of the Scots pine is much influenced by the nature of the soil and situation upon which it is grown, as well as by the age at which the tree is cut. The timber produced upon cold high-lying districts in the north of Scotland is found, when of proper age, superior to that imported from any part of Europe; while that which has been planted and reared in the Lowlands of Scotland, as well as in rather rich soils in many parts of England, is not nearly so good, although the same in age. Relative to the quality of the timber of the Scots pine, we have to state that the uses to which it is applied are almost endless, no kind of timber being so generally used for almost all kinds of purposes to which timber is applied. When of a large size, but not of timber dimensions—say of diameters between 6 and 8 inches—large quantities of the trees thinned from plantations are used for making staves for barrels for dry goods, and many other similar purposes. When of timber dimensions, and matured, it enters largely into the general economy of the country, in the form of boards and scantlings of various dimensions. And besides, vast quantities of Scots pine timber are used for railway sleepers. So great, indeed, is the demand for good and well-matured Scots pine timber for this purpose, that every one who has it to dispose of can get it sold readily at a good price. In short, our home plantations are not able to supply half the demand for this class of timber, and in consequence large quantities are every year brought from abroad.

922. *Soil and situation.*—The Scots pine is not a tree that can be said to be particular in regard to the quality of the soil upon which to grow it. The best Scots pine timber that we have ever seen grew upon a gravelly loam, resting upon a dry stratum of rotten rock, and we have seen excellent timber of this kind growing upon a dry sandy loam. A thin light surface-soil, resting on a subsoil of gravelly till, has often been observed to grow Scots pine of excellent quality of timber. The natural forests of pine in Strathspey are generally growing on land that may properly be termed a *sandy gravel:* on this description of land pine timber of large size, and of the best quality, is found growing. There, also, on *sandy loam,* the trees grow to large dimensions, and retain their timber in a healthy state to a great age —in many cases to upwards of 200 years. In short, we have seen the Scots pine growing on almost every variety of land; but we are of

opinion that a light sandy or gravelly loam is, of all others, when perfectly dry, the most appropriate for the tree.

As to situation, suffice it to say that if the land on which the Scots pine is planted be dry, it will prosper in any site not too elevated and exposed for trees to succeed in this country.

923. *Propagation and culture.*—The Scots pine is entirely propagated from seed. Few foresters have time to devote their attention to the gathering of the seed of this pine as found in our native forests; and even although they had, we have found from experience that the young plants cannot be raised by foresters on a small scale nearly so cheaply as they can be had from respectable nurserymen, who rear them on an extensive scale, and to whom a fair price ought to be given, in order to enable them to send out trees of the most reputable description. Relative to the manner of raising young plants of the *P. sylvestris*, we may state thus far on the subject at present—(we intend to enter more fully into it when we come to treat of the management of the nursery): The cones are generally ripe in the month of December, and at that time they should be gathered. When the desired quantity is collected, and the seed is wanted for sowing the spring after, they should be placed on a timber kiln made for the purpose. They may be laid on from 6 to 8 inches deep, and the heat in the kiln raised to about 110° Fahr.; but great care must be used by the operator not to raise the heat to more than 5° or 6° above that stated, or say 116°. Brick kilns, as well as metal ones, are very unsafe for this purpose, and should not be used. Even when the cones are heated on wood, very considerable care is necessary not to apply an overheat to them, as a very slight overheating would be certain to destroy the vitality of a large portion of the seeds; and it is in order to put foresters on their guard that we refer to the fact here. With the degree of heat stated, the cones should be fit for being removed in about eleven or twelve hours. The cones should be turned every two hours during the time they are heating, and at each turning all the seeds that come out should be gathered up. At the end of the twelve hours stated, all the cones will be opened up in their scales, and the seeds that remain in them will come out on being well shaken in a riddle. This is the plan adopted by nurserymen who have large quantities of cones to extract seeds from; but for a small quantity, the seeds may be extracted by exposing them to the heat of the sun, which will open their scales, and the seeds will fall out by a gentle thrashing with a light flail or piece of stick. When the seed has been extracted, it should be stored past in a dry cool place till it requires to be sown. In sowing the seed, a piece of very fine light ground should be chosen. It should be well prepared by digging and repeated raking till fine enough. The ground being properly dug, and made very fine by the

rake as the digging proceeded, it should be marked off into parallel beds of 4 feet in breadth, each bed having a path 1 foot broad between it and the next. The seed should be sown, say, at an average of *two seeds to the square inch.* When sown, it should be covered by about a quarter of an inch of very fine soil. The plants should be allowed to remain *only one year* in the seed-beds, at which stage they are termed one-year seedlings. They should then be transplanted into nursery-rows, in which, if they remain one year, the plants are termed one year transplanted, and if two years, two years transplanted—both of which sizes are planted out in the making of plantations of this tree on high-lying parts of the country. But if the plants are wanted to be about 9 inches high before they are planted out, then in that case they would require to stand two years in the nursery-rows.

924. The best crops of the Scots pine in Britain are to be found at Gordon Castle, Castle Grant, and at Invercauld. On various parts of the country trees of this species are to be found, ranging from 70 to 115 feet high, with stems from 3 to 5 feet diameter.

SECTION IV.—PINUS AUSTRIACA, OR BLACK AUSTRIAN PINE.

925. *Specific character.*—Sheath with from 3 to 5 rings, at first of a clear ash-grey, then becoming reddish, afterwards darker, and at last nearly black. Leaves in twos, from 3 to 5 inches long, seldom and but slightly twisted: when young, erect; when older, standing out, and curved towards the twig; outer surface half-round, dark green, glossy, and with a sharply serrated margin; inner surface nearly even, but slightly dotted along the ridge; points prickly, of a yellowish-brown or fawn colour. Buds large, the leader often from 1 to 1¼ inch long, ovate, with a long point. The cone does not arrive at maturity till October in its second year; it is conical, rounded at the base, 2 to 3 inches long, pointing horizontally, or nearly so; of a light-brown colour, polished, and shining. Seeds very closely resembling those of *P. laricio;* and the cotyledons 6 to 8, as in that species. The bark of the shoots of the current year is of a greenish yellow, regularly and deeply raised by the insertions of the leaves, furrowed, and shining.

926. *Geography.*—This tree grows naturally in Austria, in the Breima Forest (Wienerwald), the Banate, upon the Demoglet, near Mehadia, and in the neighbourhood of the Snowy Mountains, at higher altitudes than *Picea pectinata.* It was first introduced into Britain by Mr Lawson of Edinburgh in 1835.

927. *Description of tree.*—This tree is readily known from all the

other pines introduced into this country by its very strong and robust habit of growth, by the stiffness and strength of the leaves, by their prickly points, and by the very decided dark appearance of the foliage over the whole tree. Any one having once carefully examined the tree will not afterwards mistake it for another species, as there is a natural robustness in its whole habit which distinguishes it from all the other pines. It is, without doubt, a tree of great hardihood: in fact, in this respect it is not exceeded by the Scots pine. On several places that we have examined the woodland crops, we have found it growing luxuriantly at elevations upwards of 1000 feet above the level of the sea, and even making more rapid progress than the larch and Scots pine which grew along with it. Besides its hardiness, it has the advantage of a very natural and irregular outline in the distribution of its branches; and from this we consider it a tree well worthy of a place in an ornamental point of view.

928. *Economic uses of timber.*—Although, in Britain, we have not yet any old trees of the species by which to judge of the tree as a timber-producing one, we should say, looking at its general appearance and habit, that it is destined to become of very considerable importance in this country as timber. It is well known to be greatly valued for general purposes in Austria, even as the *P. sylvestris* is in Britain.

929. *Soil and situation.*—We have not found this tree at all particular in regard to soil, if it is not stiff nor wet. The best specimens we have seen of it grew upon a sloping dry bank, where the soil was a light loam, and deep and porous. We have, however, seen thriving plantations of it on most kinds of land, but these were always made dry by drainage, if not so naturally. It is a tree well adapted to produce a great degree of shelter to more tender kinds planted along with it, as its massy foliage forms a great protection from winds, and its rapid growth insures this within a very short time after planting. It is said to attain large dimensions of timber in favourable situations, and from its general habit we are quite prepared to believe this. It thrives well on sites by the sea-shore, and in this respect is nearly as hardy as the cluster pine.

930. *Propagation and culture.*—The seed of this tree is easily procured from the Continent, where it is indigenous. The seeds are a good deal larger than those of the Scots pine, and in sowing them, therefore, they should be much more thinly distributed on the bed than those of the Scots pine, and a little more deeply covered. In planting trees of this kind out into forest land, as they are of a free-growing and rather spreading habit, they should be distributed at distances not closer than 6 feet,—whether from other plants they are meant to shelter, or from those of the same kind growing together.

SECTION V.—PINUS PINASTER, OR CLUSTER PINE.

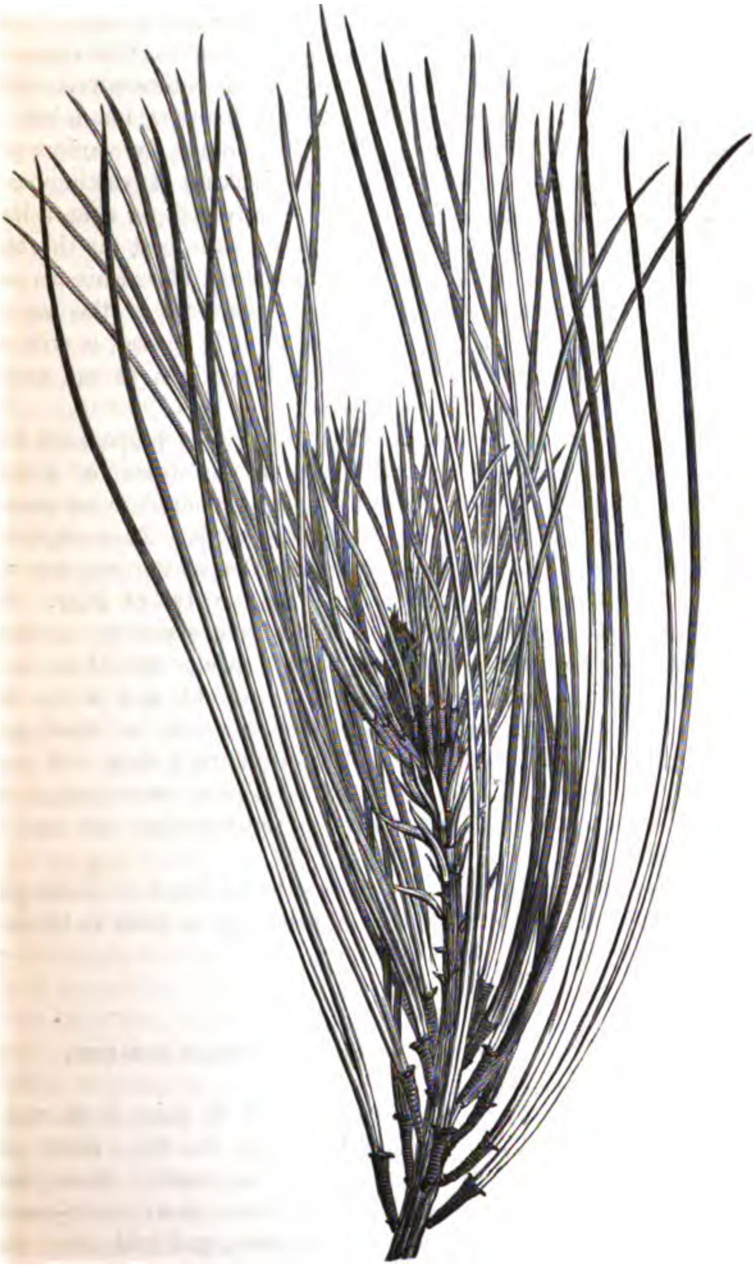
931. *Specific character.*—Leaves twin, roughish at edge. Cones oblong, conical, shorter than leaf, narrowed at base. Scales echinate.

932. *Geography.*—The pinaster is indigenous to the south of Europe, and to both shores of the Mediterranean; to Greece, and the west of Asia. It is most abundant in Spain, and on the shores of the Mediterranean. It was introduced into Britain in 1596.

933. *Description of tree.*—The pinaster is a large and rather handsome tree, varying, in Britain, from 40 to 60 and even 70 feet high, with stems from 2 to 3 feet in diameter, and when standing alone, forms a wide-spreading tree, of a massive appearance. The stem is clothed with a deeply-furrowed coarse bark, which gives the tree at all stages of its growth a peculiarly rugged aspect. The branches are in regular whorls, and always turn somewhat upwards. The leaves are in pairs, and generally from 6 to 8 inches long, although sometimes they are found nearly 1 foot in length (see fig. 114). They are slightly serrated on the margins, with sheaths from ½ to ¾ inch in length, imbricated, scarcely rigid, pale green or whitish at first, and becoming at last very dark. The cones are from 4 to 6 inches in length, and from 1¾ inch to 2½ inches wide at the broadest part, light brown and shining. The groups of cones—from three to eight—point outwards in star-like clusters, and hence the name of the pine.

This tree has a decided tap-root, which goes deep into the soil, when that is dry and favourable for its growth; but its lateral roots are generally weak in proportion to the strength of the tap one; and from this circumstance, and from the tree forming a heavy top, with dense foliage, it is generally found leaning to one side. It is a very hardy tree in all low-lying situations of Britain, but is not suited to stand on highly elevated parts of the country. No tree of the pine tribe is so well adapted to grow as a crop on our sea-shores, as in such situations it stands against the blasting influences of the strongest sea-breezes of our climate; and in this respect it is one of the most useful trees we have. This tree has been much used in France in covering immense tracts of barren sandy grounds, especially those situated on the Gulf of Gascony. The downs there are composed of drifting sands, and have been covered by thriving plantations of this tree, which are now said to be very valuable, both for the timber they produce, and on account of the resin and tar prepared from them. The tree is, at all stages of its growth, of a very branchy character; hence, when it is planted on the sea-shore, and has plenty of room to develop its branchy habit, it forms the best protection possible for the rearing of more valuable and tender trees inside; but if the trees are allowed to become at all confined, they lose their branches very quickly,

Fig. 114.



and ere long become drawn up and weakly—so that, in the cultivation of this species, great attention is necessary to keep the trees at all stages clear of each other in their branches.

934. *Economic uses of timber.*—The timber of the pinaster is soft, and by no means of a durable nature, and therefore is not to be recommended as a timber-producing tree, seeing that in this respect it is far surpassed by our Scots pine, even in the comparatively early stages of its timber. The wood of the tree is, however, much used in the south of France, and in Spain, where it abounds, for various purposes, such as boards and scantling, and the making of packing-boxes.

935. *Soil and situation.*—A deep, dry, sandy soil, or even a light loam, but always open and dry in the subsoil, suits best for this tree. It does not do well on chalk, nor any description of calcareous soil. With respect to situation, the nearer it is to the level of the sea the better will be its success. In short, as already stated, it will not thrive in Britain on any inland and high-lying site, as on such it invariably languishes and dies prematurely.

936. *Propagation and culture.*—The pinaster is propagated from the seed, which is generally procured from the continent of Europe. The seeds are pretty large, and when in the bed ought to be covered by about three-quarters of an inch of fine earth. They should be sown about the middle of April; or, when the season was late and inclined to frost, we have sown them on the 1st of May. The young plants rise up quickly, and become comparatively stout the year that they are sown. The plants of this species should be transplanted out into nursery rows when one year old, and when they have remained one year in this state they ought to be lifted again in May following, and by the second transplanting they will make excellent fibrous roots. When they have been twice transplanted, and three years of age, they will be ready for transplanting out into the forest ground.

937. Good specimens of this tree are to be found on most parts of Britain, and therefore we think it unnecessary to refer to those on any particular estate.

SECTION VI.—PINUS RESINOSA—THE RESINOUS OR RED PINE.

938. *Specific character.*—Bark red; leaves in pairs, from 4½ to 5½ inches long; straight, rigid, and yellow at the tips; dark green in colour. Sheath nearly 1 inch long, and lacerated. Cones about half the length of the leaves, of a reddish-brown colour, ovate-conical, and rounded at the base; generally in clusters, and with very short foot-stalks. Buds long—usually 1½ inch—acute, and resinous.

939. *Geography.*—This tree is found in Canada, Nova Scotia, and

the Northern States of the Union. It is never found growing to a large extent in any particular part of its native forests, but only in comparatively small portions of crop here and there—not covering many acres in extent in any one place. It is seldom found intermixed with other pines, or with any other kinds of trees, but generally alone, and always on dry, gravelly, sandy, or rocky parts, and never on flat lands with a cold bottom. Introduced into Britain in 1756.

940. *Description of tree.*—The timber of this tree is decidedly the best produced from the American woods, and besides this quality in respect to its timber, it is also a good-looking tree when standing alone with its branches fully developed. This tree has a distinctive character from all other pines that we have seen fully developed—which is, that the leaves are borne in dense bunches on the ends of the branches, thus giving it a peculiar outline from all others of the tribe, and by which it is at once known and recognised even at a distance, and when found growing among other pines. In our rambles through the American forests, we could always, at a glance, even when four or five hundred yards distant from a group of those trees, distinguish them from other pines by the redness of their bark and the tufted appearance of their leaves on the ends of the branches. We have never found this species attaining very large dimensions, even in its native forests—seldom more than 80 feet high, with stems from 18 to 30 inches diameter at 5 feet from the ground. The only specimen we ever saw larger was on a rocky part on the banks of the river Ottawa: there, in one instance only, we found a tree measuring 35 inches diameter at 5 feet from the ground, all the others that grew with it being only from 15 to 25 inches diameter at the same height. The leaves are thickly set on the ends of the young branches, while they are but thin on the older ones, thus giving the tree the peculiar character referred to. On examining the leaves, they have very much the appearance of those of *P. laricio*, but are much lighter in colour. *P. laricio* is the only one it resembles; but it is easily distinguished from that one by the peculiarity referred to, and by the tree being much more open and light in its aspect than *P. laricio.*

This tree has yet been but little cultivated in Britain; and from knowing its value as a timber-tree, which is of the first class, we would strongly recommend landed proprietors to plant it on favourable sites in their plantations, with a view to obtaining its timber, and on their parks as well, with a view to its effect among other trees, which, as already stated, is peculiar. It is perfectly hardy, and of a free growth when on a favourable soil.

941. *Economic uses of timber.*—The concentric circles of the wood

of this tree are remarkably close, presenting a fine compact grain; and as there is always a large quantity of resin in it, it is very heavy when newly cut up. The timber is justly prized in Canada and the United States for its strength and durability, and it is well known in Britain under the name of *red pine*, large quantities of it being imported every year from Quebec. It is employed in inside house-finishing in America, and for boat-building, &c. &c. It makes beautiful clean timber. We have often seen it cut up at saw-mills on the Ottawa into planking upwards of 35 feet long, without a single knot being exposed to view. For its timber qualities this tree cannot be too much extolled.

942. *Soil and situation.*—The red pine delights in a dry, sandy, or gravelly soil, or on one formed from the *débris* of rock. In Canada we never saw this species on any soil other than those formed from sand and gravel, and we in all cases found it on knolls and ridges perfectly dry. Therefore, in planting this tree in British plantations, it should be used on soils of a similar nature, and never on flat or low-lying sites where there is any tendency to coldness or wetness in the subsoil. As to situation, it should be planted in the interior of a plantation, where it will have shelter from the surrounding trees —as, in its native sites, it is always found surrounded by other trees, which shelter it from all points.

943. *Propagation and culture.*—The seed of this species is easily procured from any seed-dealer in America. In sowing the seeds and transplanting the young plants into rows in the nursery, the work is in all respects done in the same way as has been stated in respect to the propagation of the *P. sylvestris;* and the recommendations stated under that head in respect to propagation and culture are equally applicable here.

944. Of this species there are some healthy and promising specimens in Britain, and we may only refer to those at Kew in England, and to those at Castle Kennedy in Scotland.

SECTION VII.—PINUS PYRENAICA, OR PYRENEAN PINE.

945. *Specific character.*—Leaves 2 in a sheath, from 5 to 7 inches long, in tufts at the extremities of the shoots, having long sheaths, and of a light and bright green colour. Cones 2½ inches long, conical-oblong, generally solitary, short-peduncled, smooth, light yellow, and standing out nearly horizontally to the branches, and somewhat recurved.

946. *Geography.*—This species seems to be confined chiefly to the Pyrenees, hence its name. It is found in the forests of both France

and Spain, often occupying the highest ranges of the mountains in those countries, and hence its well-known hardiness in our climate, even in the north of Scotland. It is said to grow intermixed with other pines at very great elevations on the Pyrenees, and to be found only on dry parts. Introduced into Britain in 1834.

947. *Description of tree.*—This is, without doubt, one of the handsomest species of the genus, forming, when well developed, a majestic tree, from 70 to 80 feet high, and with a proportionate girth of stem. It is a highly ornamental tree when found standing alone with its dense masses of foliage, which is of a clear, transparent green colour, giving the whole tree a noble aspect and a very striking effect. It is very hardy, and grows to a considerable size in a comparatively short time; consequently we have to recommend that it should be extensively planted in Britain as an ornamental tree, for which it is well adapted. It is easily recognised from the other species of the family by the beautiful transparent colour of its bark and foliage, and by the cones, growing for the most part singly on the young shoots. The leaves are long and fine, but very strong and upright, and arranged round the branches like the hairs of a camel-hair pencil. The branches are stout and of a bright orange colour, and the buds are conical, with a long tapering point, covered with downy scales, and full of resin. The tree when young resembles *P. halepensis;* but when it becomes older it grows more rapidly, and consequently attains a higher stature, and also a more pyramidal form. The cones also resemble those of *P. halepensis* on strong foot-stalks; but instead of pointing downwards, they are always in a horizontal direction. These remarks are, we think, sufficient to enable the young forester to distinguish this beautiful pine from all the others.

948. *Economic uses of timber.*—The timber of this pine is said to be white and dry, and nearly without turpentine. It is said to have been much used by the Spanish Government in their arsenals of Carthagena and Cadiz for the decks of their ships; but from any information we have gathered in respect to the timber of this tree, we are led to say that it is of inferior quality as compared with that of many other pines we grow; therefore the place of the tree in British rural economy is that of an ornamental one on parks and lawns, and along the sides of roads in plantations, &c., for which purpose no pine is better adapted.

949. *Soil and situation.*—We have found this pine thriving well and making rapid progress on most soils of a fair loamy character, and dry; but the best specimens we have seen of it grew on a light, deep, dry, sandy loam. Although the tree is perfectly hardy, still it requires to be sheltered among other trees in order to insure its full development to the majestic proportions it is capable of attaining.

950. *Propagation and culture.*—The seed of this pine is procured from the Continent, and may be had from any respectable seed-merchant there at a moderate cost. It should be sown in beds, or in a bed, according to quantity, in the same way as has been already detailed in reference to the sowing of *P. sylvestris.* In after-treatment the young plants should be planted out in nursery-rows in the same way as recommended for the plants of *P. sylvestris,* and kept in them till large enough to be transplanted into their permanent sites. Some sow the seeds of this and other of the newer pines in cold frames, and in boxes in glass houses, but we object to this mode of treatment in all cases where it can be avoided, as by far the healthiest and hardiest plants of the cone-bearing kinds of trees are procured by sowing the seeds on the open ground, in the usual way we do with the Scots pine. In propagating all the newer coniferæ, however, a good plan is to *shade* the beds by cloth stretched over them, fixed on iron or wooden pins made for the purpose: this cloth may be of any convenient kind, and should be stretched about 1 foot above the surface of the beds. By being thus shaded, the seed germinates better than when exposed to the sunlight; but as soon as the young plants appear, the shades should during cloudy weather be removed.

951. At many places, both in England and Scotland, there are thriving and ornamental specimens of this tree to be found, especially at Dropmore, Hopetoun House, Keir, and Castle Kennedy.

SECTION VIII.—PINUS MUGHO—THE MUGHO PINE.

952. *Specific character.*—Leaves two in a sheath, from 1½ to 2½ inches long, twisted, rather broad, stiff, and of a dark-green colour. Cones conical, somewhat shorter than the leaves, sessile, very resinous, generally in pairs, but sometimes three together, somewhat erect, with the scales ending in a pyramidal, quadrangular, recurved spine. Branches very numerous and ascending, thickly clothed with leaves, and with a brownish-grey bark.

953. *Geography.*—This species of pine is found on the mountains extending from the Pyrenees eastward, the Alps of central Europe, and was introduced into Britain in 1785.

954. *Description of tree.*—This tree is of a dwarfish habit of growth, seldom being found more than from 20 to 25 feet high, and more generally only from 10 to 15 feet; in fact, generally speaking, it forms only a bush. This species is readily known from all others by its numerous *ascending* branches, which are thickly covered with dark-green leaves, forming, as it were, a large bush with many leaders.

It cannot be considered in the light of a timber-tree, as it seldom has stem enough to make it valuable in this respect; but as an ornamental specimen in plantations it is certainly deserving of a place, especially on any bare, exposed, and prominent point, as its great hardiness insures its making a very ornamental cover on such places, where the very dark green of its foliage gives an agreeable and decided effect when contrasted with the lighter green of other conifers, and with that of all hard-wooded trees. It is also well adapted to plant with a view to hiding out any object not desirable to be seen from roads or walks leading through parks or lawns, as its very numerous and densely clothed branches completely shut out from view any object immediately behind them.

955. *Soil and situation.*—This species will succeed on any soil and situation on which the Scots pine grows, as it is equally hardy, and grows on the same descriptions of land naturally. In respect to soil and situation for this tree it may be remarked here, however, that on low-lying parts of the country, and on a good deep sandy loam, it becomes a tree of some size; but on high-lying parts, where it is much exposed, and on a poor thin soil, it forms only a many-headed bush.

956. *Propagation and culture.*—This tree is propagated from seed in the same way as the Scots pine. The seed is got plentifully from the older trees growing in this country, and of course can be obtained from the Continent from any respectable seed-dealer there.

957. This tree is to be found in most collections of conifers in Britain, forming specimens of from 15 to 25 feet high.

SECTION IX.—PINUS LARICIO, OR THE CORSICAN PINE.

958. *Specific character.*—Leaves two in a sheath, lax, from 5 to 7 inches long, dark green, often twisted, sheathes short (see fig. 115). Cones sometimes solitary, sometimes in pairs, and sometimes, but rarely, in threes or in fours, seldom more than 3½ inches long, generally shorter, and 1½ inch broad near the base, conical, straight, or sometimes slightly curved near the point. Buds from ¾ inch to 1 inch long, with a long narrow point, and resinous, ovate, and from ⅜ inch to ½ inch broad. The centre bud is generally surrounded by three or more small buds.

959. *Geography.*—This species was first discovered in Corsica, hence its name. It is said to form large forests on the mountains of Sila in Calabria, and it has been found spread over the countries of the south of Europe, in Greece, Crete, and Spain, and is said to have been found in Caucasus in Russia. It was introduced into Britain in 1759.

960. *Description of tree.*—The *P. laricio* is a rapid-growing tree,

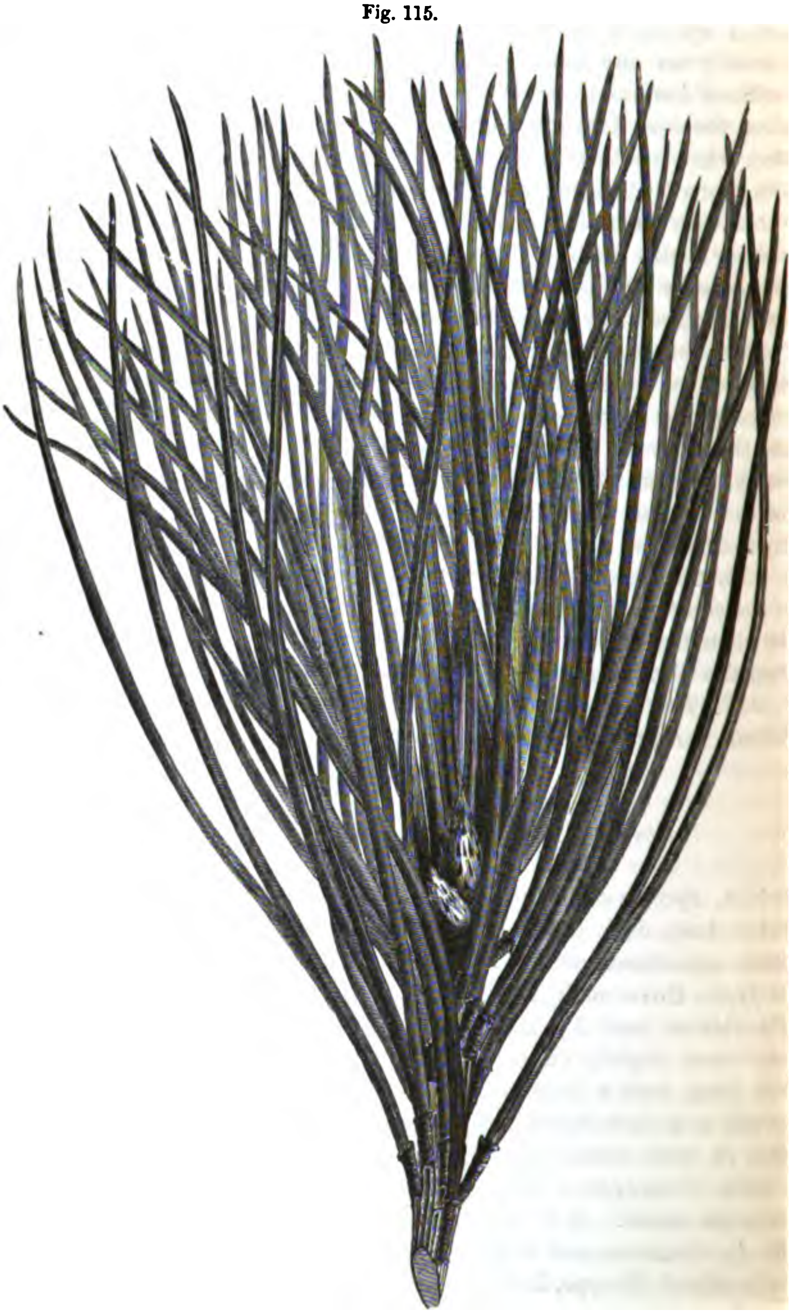


Fig. 115.

attaining heights of from 80 to 150 feet, with proportionate girths of stem, according to soil, situation, and climate. It is a very hardy and accommodating tree, and is said to be found on Mount Etna at elevations between 4000 and 6000 feet; and indeed our own experience of the tree in this country fully establishes its hardihood as a tree in all respects adapted to become valuable in Britain as a timber-producing one. It forms a handsome, open-branched, pyramidal-shaped tree, growing very rapidly, and coming to maturity comparatively early, generally in from 70 to 90 years after planting. From this pine having now been about one hundred and twenty years in this country, it is plentifully distributed over most parts of it, and is a general favourite with all tree-growers, as it is both free-growing and ornamental in its general character. It is easily known from any other of the many pines introduced by its very rapid and upright growth, often making from 2 to 3 feet of growth in its leading shoot in one season, and indeed seldom less than 2 feet additional height every year after it has become well established in its site. It is also easily known from the other species by its branches being in regular whorls, spreading out in an open and horizontal way, giving the whole tree that free, open, airy character which is so peculiar and graceful in this species; and, we may add, it may be readily distinguished by its leaves being wavy and looser set on the branches, and having shorter sheaths than most other pines of the same class, by their being thinly dispersed over the shoots, and by the terminal buds of its shoots being comparatively long, and tapering to a point. In our opinion there are few of the pines that have been introduced into this country that promise to become so useful as the one now under notice. Even in this country it grows much more rapidly, and attains a larger bulk of timber in a given time, than the Scots pine, all circumstances alike. It flowers in May, and its cones are ripe in November of the second year.

961. *Economic uses of timber.*—The timber of this tree is of a whitish colour, but brownish in the heart-wood, well impregnated with resin, but coarse in the grain. It is, however, of an elastic quality, is very easy to work, and is said to be very durable. Of course we have no experience of its timber as grown in this country, but as there is a considerable extent of land under a crop of it now in Britain, we are likely, ere many years elapse, to have proof of the quality of home-grown timber of this species. We have no doubt, however, it will yet be found valuable as a timber-tree in this country, and therefore strongly recommend it to be grown in masses, either by itself or among larch, which can be thinned out as it advances.

962. *Soil and situation.*—This tree is by no means particular in regard to the quality of the soil on which it grows, provided that it is porous, deep, and dry. We have seen healthy crops of it on most

soils, from a stiff clay loam to a sandy soil; but, like all other pines, it makes the most rapid growth on a light, dry, sandy loam, with a deep open subsoil. It makes the least progress on cold-bottomed clay lands. The more sheltered the site is, the better does it develop itself. Indeed the tree does not prosper well on high-lying situations in this country, as its comparatively weak roots are not adapted to resist the action of high winds on its heavy top. Its natural habitat seems to be in low-lying or moderately elevated parts, where it is not exposed to high winds. In all other respects it is as hardy a tree as we have.

963. *Propagation and culture.*—This tree is in all cases propagated from seed, which can be got from the Continent in abundance. The seeds should be sown in beds, thinly, say not closer than one to the square inch; and as they are pretty large—twice as large as those of the Scots pine—they should be covered a little deeper than has been recommended for them, say to about three-eighths of an inch.

964. This species of pine is now plentiful on most estates in both England and Scotland, many specimens being now found from 50 to 80 feet in height, with stems in proportion.

SECTION X.—PINUS PUMILIO, DWARF OR MOUNTAIN PINE.

965. *Specific character.*—Leaves two in a sheath, curved, short, stiff, somewhat twisted, thickly set on the branches, from 2 to 2½ inches long, with long, lacerated, woolly, white sheaths when young, but which afterwards, as they get older, become much shorter, and dark brown. Cones from 1½ to 2 inches long, and ¾ inch broad near the base, two or three growing together, reddish or dark-purplish brown when young, and dull brown when mature; when young, erect —when mature, pointing outwards. Buds ovate, blunt, resinous. Branches turned upwards, and very numerous, forming a dense bush, with the lower branches creeping on the ground, but growing, in favourable situations, into a small tree from 20 to 30 feet high, with a grey and rather smooth bark.

966. *Geography.*—This pine is found on the mountains of central Europe, on the southern slope of the Alps, towards the east, and beyond the usual limits of trees, but scarcely higher than 7500 feet, nor lower than 4000 feet of elevation, where it prefers a swampy soil. It also grows on the northern slope of the Alps, and is very common on the Carpathians, where it forms a region above the common spruce fir, and at great elevations it becomes stemless, and a spreading bush creeping along the ground. It was introduced into Britain in 1779.

967. *Description of tree.*—This species of pine forms a pretty evergreen shrub more than it assumes the character of a tree, and on this

account is very interesting as a variety among other pines or trees of a taller habit of growth. Every one of taste admires the aspect of the *P. pumilio* when it is seen among the giants of its tribe, as it relieves the sameness of character that the latter present when they are viewed as a whole among themselves. It forms a beautiful bush when planted in woods on the sides of roads running through them, and in that situation contrasts pleasantly with the outlines of the taller trees growing on the background, and it is in this position that we recommend its being used. It closely resembles a Scots pine of low growth, only it is less glaucous in the general appearance of its foliage. The leaves are also much more thickly set on the branches, and the sheaths on the leaves of the current year are much longer and whiter, especially towards the extremities of the shoots. In short, this species is readily recognised from all the others of the pine family by the character of the leaves and buds just given; and to assist the young forester still further in distinguishing it from other species, we may add that the species under notice seldom makes growths of more than 4 inches in length in any one season. And, in addition, we may remark that on breaking a branch a fluid resin flows from the broken part, giving off a fragrant smell, different from the smell of the resin of other pines of the class.

968. *Soil and situation.*—This is a very hardy species, and will grow on any soil and situation with the Scots pine. In fact, it is by no means particular in respect to soil and site on which to grow, as it is found to succeed well on most soils. Still, to have it attain the size it is capable of, it should be planted in the shelter of other trees, or in such situations as the sides of roads or walks leading through plantations, as there the vigour of its foliage is increased by the shelter afforded it; and it forms a dense, ornamental, and very large and spreading bush, very pleasing to look at when seen among hardwooded trees, especially in winter.

969. *Propagation and culture.*—The tree produces its seeds at the same time of the year as the *P. sylvestris*, and the cones should be gathered and dealt with, in order to procure the seeds, in all respects as recommended for obtaining the seeds of that species. It should be sown in the same way as the seeds of the *P. sylvestris*, only covered more lightly, as the seeds are smaller.

970. At Dropmore this species is found about 20 feet high; at Castle Kennedy it is about 10 feet in height; and at various other places, both in Scotland and England, it is found from 12 to 20 feet in height, forming wide-spreading bushes of a very ornamental character.

SECTION XI.—PINUS INOPS, JERSEY OR SCRUB PINE.

971. *Specific character.*—Leaves two in a sheath, sometimes in threes, but seldom; from 2 to 3 inches long, rigid, and sharp-pointed, bright-green, and scattered equally all over the younger branches. Sheaths short, entire, and about ¼ inch long. Cones solitary, oblong-ovoid, tapering slightly to a blunt point, and drooping; from 2 to 3 inches long, and 1¼ inch broad, frequently curved, very hard, and of a glossy yellowish-brown colour, with short peduncles. Branches irregularly placed on the stem, twisted, with the more slender branchlets pendulous, and the young shoots covered with a fine, violet, glaucous bloom. Buds blunt-pointed and resinous; the stem and larger branches emitting tufts of leaves or abortive shoots.

972. *Geography.*—This pine is found very abundant in the most of the Northern States of America, and especially where the soil is of a poor and sandy description; and in such situations it grows from 15 to 30 feet high. In the barren sections of New Jersey, particularly, this species covers large tracts of waste lands, which are known as the Pine Barrens. It was introduced into Britain in 1739.

973. *Description of tree.*—This forms a tortuous-branched low tree, having a large portion of the more slender branches pendulous, and the wood of the shoots of the current year very glaucous, and tinged with violet—a character which may be said to be almost peculiar to this species—while the stem and larger branches produce small tufts of leaves or abortive shoots. The branches grow from the stem, not in whorls, but irregularly, more in the manner of deciduous trees than is usual with the Abietinæ. The bark in old trees is deeply cracked, and through the fissures resin exudes in such abundance as to give the stem and branches the appearance of being candied over with sugar. The appearance of this tree is peculiar and striking, as the whole plant, when old, is almost covered with exuding resin, which emits a very pleasant fragrance or balsamic odour, especially during sunny weather. From these peculiarities the tree is easily recognised from other pines. It cannot be recommended as a timber-producing tree, but it well deserves a place on the sides of roads in woods and plantations, where its singularity of form and its delightful fragrance give it an interest which makes it worth cultivating in an ornamental point of view. It is, withal, very hardy. In Britain the resinous matter does not exude nearly so plentifully as it does in America, where the sun is warmer.

974. *Soil and situation.*—Although in its native habitat this tree is generally found only on dry sandy wastes, still it will grow and

prosper on most lands that are of a dry and light character. It succeeds best in Britain when planted within the influence of the shelter of other trees, and on such situations as the sides of roads in plantations.

975. *Propagation and culture.*—The seed of this species is procured from America. It should be sown on fine, light, dry, and well-prepared ground, and covered very slightly, as the seeds are small.

976. At Derby Arboretum this species is about 20 feet high; at Kew it is 20 feet high; and at Castle Kennedy it is about 18 feet high. On various other places in England, however, it has attained heights of from 20 to 30 feet.

SECTION XII.—PINUS MURICATA, OR BISHOP'S PINE.

977. *Specific character.*—Leaves generally two in a sheath, but sometimes in threes; from 3½ to 4½ inches long; stiff, broadish, blunt-pointed; of a deep-green colour; hollow on the inner side, and round on the outer, and not thickly distributed on the branches. The sheaths are rather short, not over ½ inch in length, and smooth. Cones generally in clusters of from 3 to 6, and set in whorls round the stem: they are reddish brown when young, but changing to a grey colour when old; somewhat pendulous, and nearly straight; from 2½ to 3½ inches long, and from 1½ to 2 inches broad near the base, and tapering to rather a blunt point. The base is slightly uneven, and the cone sessile, or nearly so. Scales largest on the outer side of the cone, particularly those near the base; on the inner side of the cone, and at the point, they are the smallest, except those near the point, which are rather more elevated than the others, with a slight ridge running across their middle, terminated by a short, straight, broad prickle in the centre: each cone contains from 9 to 10 rows of scales, within each of which are two very small dark-brown seeds, with wings ½ inch long. Branches irregular, not numerous, but tolerably stout. Buds below the middle size, imbricated, much pointed, and destitute of resinous matter.

978. *Geography.*—This is a very distinct pine, and was first discovered by Dr Coulter at San Luis Obispo, in Upper California, to the south of Monterey, at an elevation of 3000 feet, and within ten miles of the sea-shore. Mr Hartweg found it growing on the western declivity of the mountains near Monterey, and within three miles of the sea-shore. Mr Jeffrey found it on the Siskyon Mountains, California, at an elevation of 7500 feet, growing in moist soil near the summit. Introduced in 1848.

979. *Description of tree.*—The *Pinus muricata* does not attain

large dimensions, but forms rather a stunted character of tree, seldom being found above 40 feet high, with a stem of some 12 inches in diameter. It has very much the appearance of the *Pinus insignis* at first glance, but is quite a distinct tree when inspected. It is perfectly hardy, and is well deserving of a place in our parks, and on the sides of roads in our plantations, as a small-sized ornamental tree.

980. *Economic uses of timber.*—This pine is not calculated ever to become a timber-tree in Britain, as it does not attain sufficient size for this. It is merely as an ornamental species that we recommend it, and for this purpose it deserves cultivation with us.

981. *Soil and situation.*—This species grows well on any good light soil, but it requires with us a good and sheltered site, where at the same time it has free light and air. It does not stand confinement among larger trees.

982. *Propagation and culture.*—This tree is raised from seeds, which are procured through American agents. Even in California, its native region, it is not found very plentifully; therefore the seeds are scarce, compared with those of some other kinds, and are high-priced. The seeds are small, and should be sown on finely-prepared soil, and but slightly covered. After sowing, the bed should be shaded by a cloth stretched over it, or with spruce-fir branches, as some do, in order to prevent the sun and weather injuring the seeds before they vegetate. As soon as the young plants begin to push up, however, the covering should be gradually removed, and, if possible, during dull weather; as, if removed during dry sunny weather, the change from shade to sunlight would be certain to kill a large proportion of the plants. The seeds of none of the newer coniferæ should be sown till well on in the month of April, or even till the 1st of May, as, if earlier, the plants are very apt to be injured by frosts in our uncertain climate.

983. Specimens of this pine are plentiful in all good collections of the newer coniferæ, many of heights from 20 to 25 feet.

SECTION XIII.—PINUS PALLASIANA, OR THE TAURIAN PINE.

984. *Specific character.*—Leaves in twos, long, sharp-pointed, erect, rigid, 5 to 6 inches long, and channelled above; smooth, crowded, and of a shining dark green; sheaths short, ½ inch long, covered with scales, and torn on the margin; white when young, but dark brown when old. Cones ovate-oblong, tapering to a point, without foot-stalks, often curved near the end, 4 or 5 inches long, and 1¾ inch broad at the widest part near the base; horizontal or incurved

downwards, mostly single, or in threes round the branches, and of an ash-grey colour. Buds ovate, 1¼ inch long, and resinous, with the sides hollow. Branches scattered irregularly along the stem, robust, and incurved upwards, with some of the lower ones nearly equal to the stem in size.

985. *Geography.*—*Pinus Pallasiana* seems to be confined chiefly to the central regions of the Crimea, forming considerable forests on the western slopes of the chain of lofty mountains which run along the coast of the Black Sea. Loudon says this species was first introduced into England by Messrs Lee & Kennedy of the Hammersmith Nursery, who raised a number of plants from seeds sent to them by Professor Pallas from the Crimea about 1790.

986. *Description of tree.*—*P. Pallasiana* forms a large tree of spreading habit, generally sending out numerous large, declining, and horizontal branches from the summit to the base, the lower branches often nearly equalling the trunk in size. The bark becomes cracked, rugged, brown, and scales off. It is a rapid-growing tree, and is easily distinguished from the other pines of its class by the knottings of the stem, and by the large dimensions that some of the lower branches generally attain. The tree is perfectly hardy, and grows rapidly, and is well deserving of a place in our parks as an ornamental object.

987. *Economic uses of timber.*—The timber of this species is said to be of a very durable nature, but judging from the character of the older specimens we have in this country, it must be exceedingly difficult to work on account of its knottiness. It cannot, therefore, in our opinion, be recommended as a timber-tree with us, as we have many other pines equally as durable in the quality of their timber, while they are much more easily worked into planks.

988. *Soil and situation.*—This species accommodates itself to a considerable variety of soils, which is a great advantage it has over many others of the newer pines. We have seen excellent specimens of it on poor, thin, gravelly soils, and others on a stiff loam; but in all cases it requires a dry and open subsoil. It grows well also on chalk lands, and prospers in maritime situations.

989. *Propagation and culture.*—The seed of this tree is procured from the continent of Europe, and healthy plants may be reared from it by sowing it in beds in the common way, as recommended for the propagation of *Pinus pyrenaica.*

990. At various places, both in England and Scotland, good specimens of this pine are to be found, many of them standing from 60 to 80 feet high.

SECTION XIV.—PINUS PERSICA, OR THE PERSIAN PINE.

991. *Specific character.*—Leaves in twos, twisted, rather stiff, sharp-pointed, and not spreading; dense, and tufted towards the ends of the branches; of various lengths, from 2 to 5 inches long, deep green, channelled on the inner side and convex on the outer one, with the edges rough and finely serrated; seldom remaining longer on the tree than the second year. Sheaths persistent, short, ⅛ of an inch long, rather smooth, but shrivelled, not jagged at the ends, and guarded at the base with rather a broad, lanceolate, recurved scale, of a bright-brown colour, although green at first. Cones ovate, tapering to a very blunt point, and rounded at the base, 5 inches long, and 3 inches across at the widest part; mostly in clusters round the stem or principal top branches, but frequently solitary, and pointing downwards; of a dull greyish-brown colour, with a hard smooth surface, short foot-stalks, and destitute of resinous matter. Scales slightly elevated, nearly 1 inch broad, with apex depressed, and hollowed in the centre. Seeds large, with a broad wing 1½ inch long. Branches regular, short, and rather slender, but mostly pointing upwards; the larger and older ones rather naked on the lower parts, but tufted with leaves towards the points. Buds imbricated, very thready, and free from resin.

992. *Geography.*—This species is a native of the south of Persia, and was introduced by the Hon. W. F. Strangeways.

993. *Description of tree.*—This tree very much resembles *P. halepensis*, but is readily distinguished from it by its longer and stiffer leaves, and by their being somewhat twisted, which is not the case with the leaves of the *P. halepensis.* The cones of this tree are also much larger than those of the *P. halepensis;* besides, the latter tree is generally one of a low and spreading habit of growth, while the one under notice is of free growth, attains large dimensions, and is tolerably hardy.

994. *Economic uses of timber.*—We have no specimens of this tree that have attained sufficient size in this country to enable us to judge as to the quality of its timber. Speaking, however, from what experience we have had of this species, we are disposed to say that it is not likely to succeed in Britain to such an extent as ever to become valuable on account of its timber; for although it is hardy enough to grow as an ornamental specimen on sheltered and warm-lying sites, it is by no means adapted to grow even on moderately elevated and exposed sites.

995. *Soil and situation.*—The *P. persica* requires a deep, dry, light loam to succeed well on, and at the same time a warm and sheltered site.

996. *Propagation and culture.*—The seed of this species is as yet very scarce, and to be had only through seed-merchants on the Continent. When procured it should be sown on a piece of fine light dry soil, in a warm site, and shaded till the young plants appear, when they should be gradually exposed to full light and air. Some sow the seeds in a cold frame, and transplant the young plants into the open ground when one year old. They require to be protected under a frame during the first winter.

997. Fair specimens of this tree are still very scarce in the country, and we can only refer to those at Kew as being the best we have seen.

SECTION XV.—PINUS PINEA, OR STONE-PINE.

998. *Specific character.*—Leaves in twos, from 4 to 8 inches long, strong, straight, and of a deep shining green colour: on young plants they consist of a glaucous single bract-like leaf, thickly set on the shoots, and without any sheaths, and from amongst which afterwards spring the true leaves; sheaths when young ½ inch long, but afterwards become torn, and reduced to half their size. Cones from 4 to 6 inches in length, ovate or round in form, solid, somewhat reflexed, glossy and pale brown in colour, and not coming to maturity till the third year. Scales large, from 2 to 2½ inches in length, and 1 to 1½ inch broad, thick, angular, four-ribbed or six-sided, with a blunt spine on their apex. Branches spreading, and when old well clothed with deep-green foliage, forming a round or bushy tree, with a reddish bark, which is generally cracked and furrowed.

999. *Geography.*—The stone-pine is a native of Italy, Spain, Greece, the coast of Barbary, and some parts of western Asia. It is also found wild in the south of France, but its being a native there is doubtful, as it never forms forests, and very rarely woods of any considerable extent. Introduced in 1548.

1000. *Description of tree.*—In Britain this species attains only the size of a low tree, having a round and bushy appearance, from 20 to 25 feet high. Its character among other trees is, however, very striking, its long leaves and round cones producing a fine effect on trees of some standing, when these are found growing among pines of an upright habit, or among hardwoods. This tree is often mistaken for the *P. pinaster*, as the leaves of the two trees are pretty much alike. The habits of the two trees are, however, quite distinct, as the latter—the *P. pinaster*—grows up quickly into a tree of open form, attaining in a few years timber dimensions, while the stone-pine in all cases retains its character of a large-spreading dense bush. In the case of trees of some age, the cones at once distinguish the trees, as in the case of the *P. pinea* these are *round,* while in that of the *P. pinaster* they are conical.

1001. *Economic uses of timber.*—The wood of the stone-pine is whitish, moderately resinous, and very light. It is used in Italy and the south of France in carpentry and joinery, but in Britain it is of no use in respect to its timber, being only cultivated for its effect. It answers well for growing as a blind to hide objects immediately behind it, as it forms a dense bush compactly clothed with its long leaves and beautifully-rounded and shining cones.

1002. *Soil and situation.*—The soil for this tree should be deep, light, and dry, and the situation sheltered and warm. The plants should not be crowded, however, but should stand free of each other, as when planted thickly, or in close contact with other trees, they soon lose their natural character, and appear unsightly.

1003. *Propagation and culture.*—The seeds of this tree may be procured from the continent of Europe in great abundance. They have a very thick shell. Cultivators generally sow them in boxes in the winter time, and keep them under a frame till spring, keeping the earth rather moist to soften the shell. In summer most of the seeds will come up, although some will remain in the earth till the second year. Some, however, break the shells of the seeds before sowing them, but this mode is apt to destroy much of the seed. The plants are very tender during the first two years, and require to be protected from our winters by being kept under glass frames. The young plants, when one year old, should be transplanted out into the open ground, and merely covered with a frame during winter. When they are three years old they will be quite hardy enough to stand our winters, and may at that age be planted out into their permanent sites. Like the *P. pinaster,* this pine has long tap-roots, and in consequence of this many cultivators grow them in pots singly, thereby avoiding the frequent transplanting which is necessary to make them fibrous-rooted when grown in the open soil. When grown in the open ground they require to be transplanted every spring, in order to secure fibrous roots for safe transplanting; and it is by this mode the healthiest plants are secured.

1004. At Derby Arboretum, at Dropmore, and at Elvaston Castle, there are fair specimens of this pine, ranging from 30 to 35 feet in height.

SECTION XVI.—PINUS HALEPENSIS, OR THE ALEPPO PINE.

1005. *Specific character.*—Leaves in twos, but sometimes in threes, of a deep green, from 2½ to 4 inches long, thickly set on the younger branches, and very slender, not remaining longer on the branches than two years, in consequence of which the branches of old trees have a naked appearance, and the head an open, thin, and straggling aspect. Buds ¼ of an inch long, imbricated, roundish, and entirely destitute of resin. Cones pyramidal, rounded at the base, smooth, solitary, or in pairs, 2½ to 3½ inches long, and nearly 1½ inch broad, inversely turned downwards, with a foot-stalk ¾ of an inch long.

1006. *Geography.*—The Aleppo pine is a native of Syria, in the neighbourhood of Aleppo and Jerusalem. It is found in Barbary, on the mountains of Atlas, on the hills of Provence, and in the neighbourhood of Toulon, in France, and is common in Spain. It is always found in dry, sandy, warm soils, and thrives well among rocks, where few other trees could prosper. Introduced in 1683.

1007. *Description of tree.*—This pine may be characterised as a low, spreading tree, seldom attaining heights above 40 feet, except under very favourable circumstances. The *P. halepensis* is somewhat tender in the climate of Britain, and therefore has been very sparingly planted, although it has now been a long time in the country. In favourable situations, however, such as Dropmore, and other places in England, it has succeeded well, and become trees of no mean magnitude, some of these being considerably over 50 feet high, with stems of fully 15 inches diameter. When the tree is young it has a spreading head, with slender branches—the last two years' growths being clothed with very fine deep-green leaves, giving the tree a beautifully soft and wavy expression. When it becomes old, however, the tree has a naked and straggling character, from the leaves never remaining longer than two years on the branches. This is not a tree to be planted for the sake of its timber, but merely as a specimen in a pinetum or in a park, where variety of effect in respect to fine foliage is an object.

1008. *Economic uses of timber.*—The wood of this pine is white, and has a very fine grain. On the Continent the tree attains large dimensions of timber, and there the wood is considered very superior, and is used in joinery. In Britain, however, it is not adapted to grow as a timber-tree, but merely as an ornamental one, in favourable situations.

1009. *Soil and situation.*—In Britain this tree requires a light, dry soil, and a sheltered and warm situation. It does not succeed on a rich soil, as under such circumstances growth is too much excited, the young shoots are rendered too succulent, and in consequence they do not ripen well under our sun, and hence are killed the first winter after. To grow this species at all well, even in England, it must be planted in a poor, light, dry soil, on which the growth is but little excited during the first three or four years after planting. Under these circumstances the plants will make but little progress for some time; but then, this is the saving of them for after success. Their fibre is thus rendered firm, and in consequence it stands our winters, and the trees remain healthy and uninjured, and ere long, when the roots have become well established in the ground, the plants grow more vigorously, and still retain their healthy condition, and become good specimens.

1010. *Propagation and culture.*—The seed of this species is readily procured from Continental seedsmen. It requires to be sown in a warm spot, and the plants should be covered with a frame during the first two or three winters till they are of some size, and hardy enough to be planted out into their permanent sites.

1011. Fair specimens of this pine are common in the south of England.

SECTION XVII.—PINUS BRUTIA, OR THE CALABRIAN PINE.

1012. *Specific character.*—Leaves in twos, rarely in threes, from 6 to 8 inches long, very slender and wavy, glabrous, spreading, channelled above and convex below, serrulated on the margins, with a sharp point, and of a bright-green colour. Sheaths ½ inch long, of an ash colour, quite entire, and not falling off. Buds ¾ of an inch long, pointed, woolly, and free from resinous matter. Cones stalkless, generally in large clusters, but sometimes singly on young trees, ovate, and smooth, 2 to 3 inches long, and flattened at the base, of a deep-brown colour, and remaining on the tree for years. Scales depressed, umbilicate, and slightly concave at the apex.

1013. *Geography.*—This species is said to be found in Calabria, on the mountain of Aspero, at an elevation of from 2400 to 2600 feet.

1014. *Description of tree.*—The *P. Brutia* is a middle-sized tree, having many large and spreading branches, thickly set with long, bright-green foliage. The bark is of a greyish-brown colour, smooth, but covered with depressed tubercles. It resembles *P. halepensis*, but is easily distinguished from it by its leaves being nearly twice the length, and its cones being without stalks, and growing in large clusters. The habit of the tree somewhat resembles *P. laricio* at first sight, but a slight examination of the leaves shows the difference at once, those of the *P. Brutia* being very much more slender than those of *P. laricio*, and somewhat longer. It is quite hardy in most parts of Britain, and forms a fine looking, wavy-leaved, ornamental tree.

1015. *Economic uses of timber.*—The timber of this species is said to be of excellent quality, but as there are no specimens in this country old enough to enable us to form a judgment on this point, we cannot speak from experience on it.

1016. *Soil and situation.*—This species thrives well on most soils of an open dry character, where it has the advantage of a good exposure and moderate shelter. It forms a fine ornamental tree, and is well worthy of a place in every pinetum.

1017. *Propagation and culture.*—The seed of this pine is to be had through seed-merchants on the continent of Europe. It does well when sown on any warm-lying piece of ground, of a light and fine description, and not too rich to excite too much growth in the plants. The young plants are hardy and accommodating, and are fit for transplanting out into their permanent sites in the third or fourth year, according as they may be wanted as to size. Seeds of this pine are scarce, however, and therefore the plants are still high-priced.

1018. At Bicton, Devonshire, and at Castle Kennedy, in Wigtonshire, there are good specimens of this pine, ranging from 30 to nearly 40 feet in height.

SECTION XVIII.—PINUS GERARDIANA, OR GERARD'S PINE.

1019. *Specific character.*—Leaves in threes, stiff, three-edged, stout, and bluntly terminating in a short point, from 3 to 6 inches long, of a bluish-green colour, and glaucous when young. Sheaths short at first, and composed of dry, reddish-brown scales, but soon rolling up and falling off. Branches ascending, but the lower ones spreading, and the branchlets short, somewhat slender, and irregularly disposed. Cones ovate, oblong, or somewhat cylindrical, widest at the base, from 6 to 8 inches long, and from 12 to 15 inches in circumference near the base, and of a bluish colour. Scales thick, blunt, much recurved and spiny at the points. Seeds nearly 1 inch long, cylindrical, almost wingless, pointed at both ends, of a dark-brown colour, and agreeable to eat.

1020. *Geography.*—This species is said to be found in great abundance on the northern side of the snowy range of mountains in Kunawur, beyond the influence of the periodical rains, where it grows on very dry rocky ground. It is found, also, to the north of Cashmere, and on the Astor Mountains in Little Tibet. Gerard states its highest limits on the inner Himalayas to be from 10,000 to 12,000 feet of elevation. It was introduced into Britain in 1815.

1021. *Description of tree.*—This species forms a large conical-headed tree, not of a tall character, but of large dimensions of trunk. It is easily recognised from all the other three-leaved pines by the sheaths from which the leaves proceed being scaly and falling off very soon. Another peculiar feature of this species is its smooth, silvery-grey bark, which falls off in silky-like flakes. It is a very slow-growing pine, but is tolerably hardy, and therefore worthy of a place in our pinetums and parks, as its habit, which is sturdy and massive-looking, contrasts pleasingly with the taller and more slender growths of most of the other pines.

1022. *Economic uses of timber.*—We have no reliable accounts as to the quality of the timber of this species, and as we have no specimens in this country old enough to judge from, we cannot speak with confidence on this point at the present time.

1023. *Soil and situation.*—This pine requires a good, light, and dry soil, and a warm and sheltered site, to grow it successfully in our changeable climate. If there is any degree of smokiness in the air where it is planted, it will not grow at all, but will dwindle and die. Like all the other pines, it likes a pure air. In this respect, however, it is even more sensitive than most of the others, and therefore healthy plants of it are never to be had from nurseries near towns.

1024. *Propagation and culture.*—The seeds of this species can be had in great abundance from India, as there they are sold as an article of food. They should be brought home in the cones, in order to preserve their vitality unimpaired. They vegetate freely when sown in a light friable soil, but the young plants in most parts require protection during the first winter—that is, while they are 1-year seedlings. After they have been transplanted, however, they become more hardy; and in situations at all favourable, they soon become stubby and strong, and fit for planting out into their permanent sites, which should be sheltered from prevailing winds.

1025. Well-grown specimens of this species are still very scarce in Britain. It is, however, to be found in most good pinetums in England, and particularly at Kew, where the tree is now of considerable size.

SECTION XIX.—PINUS MACROCARPA, OR THE LARGE-CONED PINE.

1026. *Specific character.*—Leaves in threes, stout, and rather stiff, from 9 to 12 inches long, and of a glaucous-grey colour, ribbed on the inner side, rather flat, incurved, pointed and compressed. Sheaths ragged, thready, persistent, 1½ inch long on the young leaves, but shorter and torn on the old ones. Branches stout, rather distant, but regularly placed in whorls on the stem, nearly horizontal, slightly elevated towards the extremities, and tinged with violet on the young shoots. Cones conical-oblong, tapering to a point, solitary, very large, 12 to 15 inches long, and 6 inches broad, very hard, smooth, pale yellow, with a polished surface, and frequently weighing nearly four pounds each.

1027. *Geography.*—This species is from California, and is found on the mountains of Santa Lucia, near the Mission of San Antonia, within sight of the sea, and at an elevation of from 3000 to 4000 feet. It was introduced into Britain in 1832, and, as its name implies, its cones form a very striking feature in the character of the tree.

1028. *Description of tree.*—This is a free-growing, handsome, and hardy tree, in its native country attaining heights from 80 to 100 feet, with a stem from 3 to 4 feet in diameter. This pine is easily known from all others by its very long and stout leaves, and by the branches being nearly horizontal, distant from each other, and therefore giving the tree an open and airy aspect—and, moreover, by the violet tinge of the bark on the young shoots. This is a pine that we admire very much, its long waving leaves giving it a peculiarly graceful aspect when seen in contrast with pines of a more dense habit, or with broad-leaved trees; and besides, the glaucous grey of the leaves is seen to great advantage when the tree stands among its congeners of a darker foliage. It should be planted in every park and pinetum where a suitable soil and site can be had for it, as there are none of them more ornamental or deserving a place where variety of pine foliage is an object.

1029. *Economic uses of timber.*—We have no experience as to the quality of the wood of this species, and in the meantime can only recommend it as an interesting subject on account of the beauty of its foliage.

1030. *Soil and situation.*—This pine, although it may be said to be hardy, and is found to grow freely in many parts of the country, is rather capricious in regard to soil and site, and requires a very good, dry, light loam, deep and porous, and open and dry in the subsoil; while the site must be such as to prevent the direct rays of the sun acting on it till near mid-day. Trees of this species are often found to lose their tops from the action of the sun's rays on them in the early part of the day, after a night's frost in the beginning of summer; but where this can be avoided, the trees do well, keep their leaders entire, and form good ornamental specimens.

1031. *Propagation and culture.*—The seed of this pine may be procured either direct from seedsmen in America or through seed-merchants on the continent of Europe, who act as their agents. The plants of this species also require the protection of a frame during the first winter after they have come up; but after they have been transplanted into the open ground, they will be found hardy enough to stand in favourable parts of Britain.

1032. There are many good and promising specimens of this species in various places in Britain, but we refer only to three—viz., Elvaston Castle, Kew, and Castle Kennedy. On these places there are healthy trees of the species, of heights ranging from 25 to 40 feet.

SECTION XX.—PINUS BUNGEANA, OR CHINESE LACE-BARK PINE.

1033. *Specific character.*—Leaves in threes, very stiff, convex on the back, and acutely keeled on the inner face, from 2 to 3 inches long, and thickly set on the branches, frequently in bundles towards the ends of the shoots, somewhat in whorls, and irregularly three-edged. Sheaths composed of numerous loose scales, which soon fall off and leave the base of the leaves naked. Buds non-resinous, and formed of several reddish-brown, smooth, fringed scales, largest at the base, and rough at the edges. Male catkins from 5 to 6 lines long, cylindrical or conical; when young, placed alternately at the base of the young shoots, but frequently afterwards very distant, owing to the rapid elongation of the young shoot. Branches long, very slender, little divided, glaucous, and covered with a smooth grey bark, rendered a little rough on the stem and older branches by the transverse scars forming rhomboidal-shaped figures, which in due time are shed, and give the stem and branches a very peculiar appearance. Cones ovate or slightly conical, broadest near the base, 2½ inches long and 1½ inch diameter, and obtuse-ended.

1034. *Geography.*—This pine is a native of the north of China, and was sent here from that country by Mr Fortune. It is cultivated by the Chinese as the "lace-bark pine."

1035. *Description of tree.*—Although from China, this species is quite hardy and free-growing, and attains heights of from 30 to 50 feet. It is a very distinct and peculiar pine, as in a young state its bark resembles the skin of a pea more than that of a pine-tree. As the plant increases in age, however, the thin outer epidermis peels off in silky-like scales, leaving the branches and stem with a greyish-white surface. Another peculiar characteristic of this pine is, that in its annual production of young shoots its new leaves are at first furnished with perfectly-formed sheaths, which soon fall off, leaving the leaves sheathless, in the same way as the outer bark falls off the stem and branches. This is not a tree at all adapted to become a timber one in this country, and is to be recommended only for the peculiarity of its appearance, and for the variety it forms among other pines.

1036. *Soil and situation.*—This species comes from the coldest and poorest districts of China, and is therefore found to be quite hardy in Britain, and by no means very particular as to soil and site. The former should be light and dry, however, and the latter favourable, and not exposed to prevailing winds.

1037. *Propagation and culture.*—The seed of this species is very scarce, from the difficulty of obtaining it from the north-west of China, where it is alone to be had. It is got now and then, however, through the influence of merchants in the country. The seeds vegetate readily when sown in the usual way, and the plants soon make progress and become fit for planting out.

1038. This species is scarce as yet, and few good specimens are to be seen in the country. We may refer to three places where it is to be found, however—at Dropmore, Kew, and York Nurseries.

SECTION XXI.—PINUS PONDEROSA, OR THE HEAVY-WOODED PINE.

1039. *Specific character.*—Leaves in threes, from 6 to 10 inches *long*, at first straight, when old sometimes they are twisted, rather broad and flexible, thickly set on the branches, and sharp-pointed, and of a rich deep-green colour. Sheaths 1 inch long, smooth, but much shorter and shrivelled on the old leaves. Branches few, in regular whorls, robust, twisted, and somewhat drooping. Buds bluntly domed, with a prominent point, and full of resin. Cones straight, ovate, tapering to both ends, particularly towards the apex, from 2½ to 4 inches long, and 1¾ inch broad, sometimes singly, or in twos or threes, or in clusters round the branches, on very short stout foot-stalks, bent downwards.

1040. *Geography.*—This species is found plentifully on the north-west coast of America and in California, particularly on the banks of Spoken River and the Kettle Falls of the Columbia, west of the Rocky Mountains, and in Rose River valley in California. Was introduced in 1826.

1041. *Description of tree.*—This pine, when of some age, is remarkable for the twisted character of its branches, which are disposed in regular verticillate whorls. The timber of matured growth is said to be so heavy as almost to sink in water. The tree grows to large dimensions, generally from 60 to 100 feet in height, with few branches and a large girth of stem. It is a free-growing, hardy tree, and makes rapid progress when in a suitable soil and site.

1042. *Economic uses of timber.*—The timber of this tree, so far as we can judge of the specimens we have in this country, is of fair quality, and is likely to be serviceable in Britain for many purposes where a fine polish is not the object. It seems coarse-grained, but still strong, and as the tree is hardy and free-growing, we have no doubt it will become one of our forest-trees, producing timber for many useful purposes.

1043. *Soil and situation.*—The best specimens we have seen of this species grew on a poor gravelly soil, and on one of a sandy loam. The soil for this species, as for most others of the pine tribe, should not be of a rich nature, as under such circumstances the plants generally grow too luxuriantly, and consequently do not ripen the points of their shoots sufficiently to resist the frosts of our winter. The situation for the pine under notice should be airy, but not much exposed.

1044. *Propagation and culture.*—The seed of this species is still scarce, although it is obtained now and then from the Far West, but only in small quantities. It may be sown, and the plants produced from it reared in the usual way, as they are quite hardy and easy of cultivation.

1045. At Elvaston Castle, Dropmore, Kew, Linton Park, the Botanic Gardens, Edinburgh, and Hopetoun House, there are specimens of this pine of various heights, from 20 to upwards of 60 feet, all forming healthy and promising trees.

SECTION XXII.—PINUS BENTHAMIANA, OR BENTHAM'S PINE.

1046. *Specific character.*—Leaves three in a sheath, thickly set on the branches, dark green, and resembling those of *P. ponderosa*, but much longer on the average; generally from 8 to 11 inches, stout, somewhat flat, with a slightly-elevated rib running along their inner side. Sheaths partly persistent, and ¾ inch long on the leaves of the young shoots, slightly shaggy, except at the extremity, where they are very ragged or torn. Branches rather numerous, very stout, spreading, and somewhat irregular, with the bark rough. Buds large, dark brown, much imbricated, and free from resinous matter, although sometimes there is a little. Cones in clusters of from 3 to 5 together, slightly pendulous, and quite straight, 6 inches in length, and 2½ inches broad at the widest part, which is rather below the middle; the base is unequal-sided, owing to the numerous very small scales there curving to one side and forming a kind of hood round the base of the cone, which is quite sessile.

1047. *Geography.*—This valuable pine was first met with on the mountains of Santa Cruz in California, a coast-range running due north across the bay from Monterey; afterwards it was found in the Sacramento country, growing upon the ridge generally termed "The Californian Mountains." Introduced in 1847.

1048. *Description of tree.*—This is truly a noble pine, and is in all respects hardy, being entirely a mountain species. It is said to attain the height of 200 feet in its native habitat, with a stem from 9 to 10 feet in diameter. Mr Hartweg says of this pine: "After crossing the Chuba River, you pass the prairie and enter the mountains near Bear Creek, where you have to pass through an interminable wood of *Pinus Sabiniana;* and in ascending the gradual acclivity of the mountain, you lose the region of the *P. Sabiniana* and enter that of *Pinus Benthamiana,* which seems to be characteristic of the upper region." This species very much resembles the *P. ponderosa* in its appearance while young, but is readily distinguished from it by the greater length of the leaves. On the specimen which we have before us while we write, and which is taken from a tree of some 15 feet high, the leaves are nearly 10 inches long on the average; while those on the specimen we have of the *P. ponderosa* are only from 7 to 8 inches. This is undoubtedly one of the pines which is likely to become a timber-tree in Britain, as it is both hardy and ornamental, and therefore is worthy of a place both in the parks and in the plantations of this country.

1049. *Economic uses of timber.*—The timber of this pine is said to be lighter and more elastic than that of the *P. ponderosa,* and also of a more durable description.

1050. *Soil and situation.*—This species is by no means difficult to suit in respect to soil, provided that it is not of a heavy or clayey nature, and that it is deep and dry. We have seen it doing well in most free loamy soils, and making good progress—annual shoots of 2 feet in length—even in moderately-exposed situations. In short, this is a very valuable and accommodating pine, and should be cultivated as much as possible in our plantations.

1051. *Propagation and culture.*—A fair supply of the seed of this tree has been procured of late, and therefore it is now pretty extensively grown in most nurseries. It may be sown, and the young plants produced from it reared, in the same way as the Scots pine.

1052. At many places, both in England and Scotland, there are now found specimens of this pine from 25 to 40 feet in height.

SECTION XXIII.—PINUS RIGIDA, OR THE STIFF-LEAVED PINE.

1053. *Specific character.*—Leaves three in a sheath, from 2½ to 4 inches long, stiff, rather broad and sharp-pointed, light green, and spreading. Sheaths short, ⅝ inch long, and white on the young leaves, but afterwards becoming nearly black and shrivelled. Branches very numerous on the upper part of the tree, and compact. Cones ovate-oblong, from 2½ to 3½ inches long, and 1½ inch broad, on short stout foot-stalks, in clusters of 4 or 5 round the top branches, and remaining on the tree for years.

1054. *Geography.*—This species is found in most parts of the United States from New England to Virginia, growing either in dry soil or in wet. In America it is known by the name of the "pitch-pine." It was introduced about 1759.

1055. *Description of tree.*—In America this tree grows to a large size on some parts of the country. On light sandy lands in the State of Pennsylvania we have seen it upwards of 80 feet high, with a stem fully 2 feet in diameter. We have seen also good trees of this sort growing on the edges of swamps, where the ground was wet; but on poor high-lying parts it forms only a large-headed bush. This tree has a thick, dark-looking, coarse bark, deeply furrowed on old trees, and it is generally of a very branchy habit, seldom having a clean stem, even when found growing in masses or among other trees, and, in consequence, its wood is very knotty. It cannot be said to be a highly ornamental tree, nor is it valuable on account of its timber; but from its hardiness, and its very accommodating habits as to soil and site, it is well adapted for planting on many sites where variety is an object, and where few other sorts of pines would grow in such a way as to secure this object.

1056. *Economic uses of timber.*—In America the timber of this tree is used for many purposes where it can be had, but it is now very scarce. In Britain it is of no economic value, the tree being grown on some places merely for variety among other pines.

1057. *Soil and situation.*—Few pines are more accommodating than this one in respect to soil and site. To grow it well, however, it requires a light, friable, deep soil, not too much exposed.

1058. *Propagation and culture.*—These are in all respects the same as the Scots pine. The seeds can be easily procured from any seed-merchant in New York. The tree has been so little inquired after in Britain, however, that plants of it are extremely scarce in this country, and few nurserymen have them to dispose of at any price.

1059. When we last visited Dropmore we found specimens of this pine, of heights from 40 to 50 feet.

SECTION XXIV.—PINUS RADIATA, OR THE RADIATED CONE PINE.

1060. *Specific character.*—Leaves three in a sheath, very slender, twisted deep green, thickly set on the branches, and from 3 to 5 inches long. Sheath short, smooth, ½ inch long on the young leaves, but much shorter on the older ones, and only partially persistent. Branches compact, numerous, rather regular, and slender, particularly the lateral ones. Bark light brown, and rather smooth. Buds small, numerous, imbricated, and full of resinous matter. Cones mostly single, but sometimes two or three together, rather conical, very hard, slightly incurved, pendulous, and of a glossy light-brown colour, 6 inches long, 3½ inches broad near the base, which is uneven as well as the sides, the outer side being much the longest. Scales radiant, largest at the external base and down three parts of the outer side of the cone, deeply divided, much elevated, and prolonged into a blunt-pointed nipple, ½ inch in length and ¾ inch broad; those nearest the base being bent backwards, the others more or less convex, widest at the base, bluntly conical, slightly angular, and terminated by a blunt point; the scales on the inner side of the cone, and for four or five rows round the point, very much smaller, quadrangular, and slightly elevated, with their points quite flat or slightly depressed.

1061. *Geography.*—This beautiful pine was first discovered by Dr Coulter in Upper California, in lat. 36°, near the level of the sea, and almost close to the beach, growing singly to the height of 100 feet. Mr Hartweg met with it on the descent towards the sea on the mountains of San Antonio, sixty leagues south of Monterey, forming a small wood extending along the beach, where the deep grass-green of the foliage formed a great contrast with the parched-up vegetation around at the time. Introduced in 1829.

1062. *Description of tree.*—This tree delights to grow singly, and within the influence of the sea, in such situations growing to large dimensions, and of an upright habit. It is a beautiful pine, and very much resembles *P. insignis* at first sight; but a closer inspection shows that its leaves are much shorter and more slender than those of *P. insignis*, while its cones are nearly three times the size, and with the scales much more elevated. The *P. radiata* forms a beautiful straight-stemmed tree, clothed with branches down to the ground, which is its natural habit; and it is quite hardy and accommodating.

1063. *Economic uses of timber.*—The late Dr Coulter says that this species forms excellent timber, which is very tough, and admirably adapted for boat-building, for which purpose it is much used at Monterey. Of course we cannot yet speak of the timber qualities of the tree in this country, but looking at the specimens we have examined of it, there is every reason to believe that it will yet prove useful for its timber, as well as an ornamental tree in our parks.

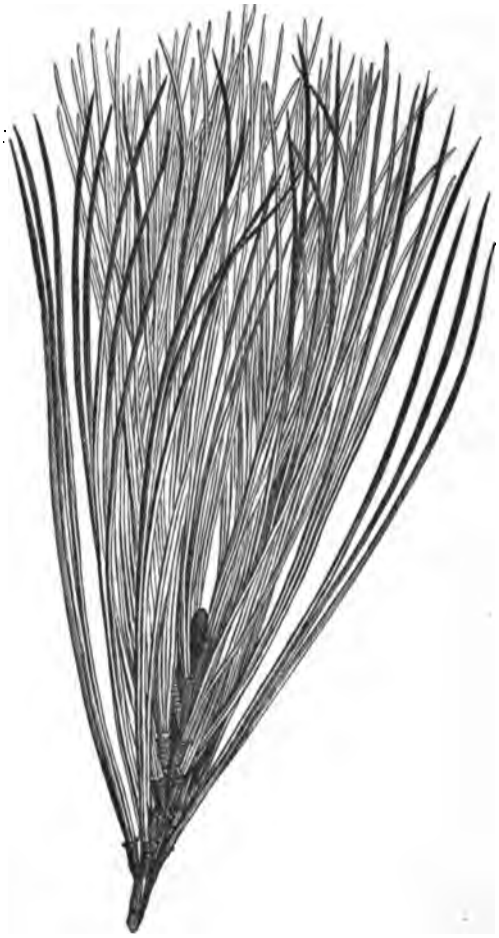
1064. *Soil and situation.*—The best specimens we have seen of this tree grew on a poor gravelly soil, on a site considerably elevated and inland. It is said to be well adapted for planting near the sea, but as we have not seen it growing on such a site, we cannot say whether it is so in this country. At all events it is quite hardy, and seems to succeed well on most light soils, not too high-lying or too much exposed.

1065. *Propagation and culture.*—This pine is easy of cultivation from the seed, but it is very scarce, and therefore still high-priced.

1066. We have got no returns as to our inquiries in regard to specimens of this species.

SECTION XXV.—PINUS INSIGNIS, OR THE REMARKABLE PINE.

Fig. 116.



1067. *Specific character.*—Leaves three in a sheath, deep grass-green, rather slender, straight, or twisted in all directions, very densely set on the branches, of different lengths, from 4 to 6 inches long, ribbed on the inner sides, and sharp-pointed. Sheaths very short, smooth, and rather more than ¼ inch long (see fig. 116). Branches numerous, rather irregular, and thickly set with slender branchlets at the extremities. Cones ovate-conical, much pointed, most developed on the exposed side, particularly towards the base or outer part, 2½ to 4 inches long, and from 2 to 2½ inches broad, mostly in clusters of from three to five, but sometimes single, of a pale yellowish brown when ripe, and with a smooth glossy surface: they point downwards, and remain for several years on the tree. It takes two years to mature its cones and seeds.

1068. *Geography.*—This very interesting pine is a native of California, and found growing in various parts of that country. It was introduced into Britain by Douglas in 1833, and has become widely spread over the country on account of its very graceful habit.

1069. *Description of tree.*—In its native country this pine attains heights of from 80 to 100 feet, with stems from 2 to 4 feet in diameter, feathered to the ground with branches, and forming an extremely handsome tree. It is tolerably hardy, and of very rapid growth, but it has a tendency to make autumnal growths when planted in low-lying sites where there is a rich soil and a humid air, and under such circumstances it is very apt to get its top frost-bitten. When planted on a somewhat high-lying and very dry site, having a free exposure to sun and air, this tendency is checked, it ripens its wood early in autumn, and in consequence is not injured by our winters. The tree is a very graceful one, having a free and irregular branched habit of growth, and its beautiful grass-green foliage renders it an admirable object on a park or lawn among other pines of a darker hue, or among deciduous trees; in the latter case it becomes truly a living statue, increasing the grandeur of the most highly finished landscape.

1070. *Economic uses of timber.*—At the present stage of the history of this tree in Britain, we cannot speak of its timber qualities, and some time must elapse before we can have specimens matured enough in their timber to enable us to judge of these.

1071. *Soil and situation.*—This species should be planted on a light, dry loam, rather poor than otherwise, and on a site where it can have free sun and air without being exposed to prevailing winds. Like many others of the newer pines, it grows on too late in the autumn when planted on rich soils and low-sheltered sites, and from this often loses its leader; but when planted as stated, it matures its shoots early, and goes on uninjured. This tree succeeds better near the sea than on inland districts, and on the west coast better than on the east.

1072. *Propagation and culture.*—This species is raised from seed in the usual way, but the young plants require the protection of a frame during the first winter, as they are apt to be injured by frost till they have formed perfect wood and leaves.

1073. Good specimens of this pine are now plentiful in the country, many of them of heights ranging from 40 to about 80 feet, with proportionate stems.

SECTION XXVI.—PINUS SABINIANA, OR SABINE'S PINE.

1074. *Specific character.*—Leaves three in a sheath, rather slender, from 10 to 12 inches long, glaucous grey in every stage, twisted, and, when fully grown, bent downwards, and drooping during winter,s harppointed, angular on the inner side, and rounded on the outer one. Sheaths 1½ inch long, nearly entire at the top, with numerous rings, and wrinkled when old. Branches numerous, not very robust, covered with a violet bloom when young, and bare of leaves, except near the extremities. Cones ovate, most developed on the outer side, particularly towards the base, pointing downwards, pressing against the stem, and remaining on the tree for a number of years, from 8 to 12 inches long, and from 4 to 6 inches wide at the swell, on foot-stalks 2½ inches long, and full of resin, particularly towards the base. Scales spatula-shaped, flat on the inner side, and rounded or slightly angular on the outer one, 2½ inches long, and 1½ inch broad on the larger ones, but much less on the smaller ones towards the base, terminated by a strong, sharp, incurved hook, particularly on the exposed side and at the base, where some of the points are quite straight, and pointing upwards or towards the top of the tree. Seeds 1 inch long, oblong, tapering to the base, and flattened on the inside, hard-shelled, short-winged, and edible, and nearly double the size of those of *P. macrocarpa.*

1075. *Geography.*—This species also is a native of California, being found there on the western Cordilleras of New Albion at a great elevation, and in woods on the heights near Monterey at El Toro, a high mountain to the east of Monterey. It was introduced into Britain in 1832.

1076. *Description of tree.*—This is a fine-looking tree, growing to heights of from 100 to 150 feet, with stems from 2 to 5 feet in diameter, regularly furnished with branches to the ground. It is said never to be found in masses or forests, but intermixed with other kinds, ripening its seeds in November. The tree is of a tapering form, resembling an abies in this respect, and its long foliage gives it a very graceful appearance.

1077. *Economic uses of timber.*—The timber of this species is said to be white, but not of a durable character; therefore it is only as an ornamental tree on our lawns and parks that it is to be cultivated in Britain, and for this it is admirably adapted.

1078. *Soil and situation.*—Although this tree is tolerably hardy, it is very particular in respect to soil and site. It is found to succeed best in this country when planted in sheltered ravines and hollows where the soil is deep and somewhat rich in well-decayed vegetable matter. It thrives well, however, on any light land not too much exposed, nor at a high elevation; but on such parts its growth is slow as compared with that in low-lying and sheltered hollows.

1079. *Propagation and culture.*—See remarks in respect to the propagation of *P. insignis,* as they are applicable to the propagation of the species under notice. The seed of *P. Sabiniana* is still very scarce, and therefore plants of it are high-priced.

1080. In most good pinetums in the country specimens of this fine-looking pine are found, of heights ranging from 20 up to 35 feet.

SECTION XXVII.—PINUS JEFFREYII, OR JEFFREY'S PINE.

1081. *Specific character.*—Leaves in threes, pendulous at the ends, deep green, keeled on the inner face, rounded on the back, very acute-pointed, and from 8 to 9 inches long; sheaths persistent, 1¼ inch long when young, but very much shorter, lacerated at the ends, and of an ash-grey colour when old. Buds short, stout, imbricated, and resinous. Branches horizontal, a little declining, rather slender, and of a light yellowish-red colour. Cones large, ovate-conical, tapering most to the point, 8 inches long, and 3½ inches in diameter at the widest part, which is near the base, and for the most part produced in clusters round the branches.

1082. *Geography.*—This species was found by Mr Jeffrey in the Shasta valley in northern California, growing on poor sandy soil, and was introduced into Britain about 1852.

1083. *Description of tree.*—This forms a handsome tree, and is hardy, and a free grower. In its native country it attains heights of from 100 to 150 feet, and has stems from 2 to 4 feet in diameter. In this country it makes fair progress, there being specimens with us over 30 feet high, although only about twenty-five years planted.

1084. *Economic uses of timber.*—We have no information as to the quality of the timber of this species.

1085. *Soil and situation.*—This tree does not seem to be very particular in respect to soil and site. We have met with fair healthy specimens on most soils, varying from a sandy to a stiff clayey loam, and on situations sheltered, and on others a good deal exposed. In short, this seems a hardy and accommodating tree, and, one would say, likely to become both useful and ornamental.

1086. *Propagation and culture.*—The seed of this pine being still very scarce with us, we sow it in good soil in a warm corner, and protect the young plants during the first winter of their existence with a frame, to prevent their being injured by frost. After they are a year old and have been transplanted, and formed perfect wood and leaves, they are quite hardy, and require no further protection. Indeed, were it not that the seed is so extremely scarce, we might not protect the plants at all during the first winter; but we are anxious to use every precaution in order to avoid risk of damage to the plants.

1087. Specimens of this pine are common, of heights from 20 to 25 feet.

SECTION XXVIII.—PINUS TUBERCULATA, OR THE TUBERCULATED CONED PINE.

1088. *Specific character.*—Leaves three in a sheath, thickly disposed on the branches, bright green, rather stiff, broad, and flat, with an elevated rib running along their middle on the inner side, 4½ to 6 inches in length. Sheaths short, smooth, and not more than ½ inch long on the young leaves, but much shorter on the older ones. Branches not very stout, rather numerous, and irregular, with a roughish bark. Buds below the middle size, imbricated, and not very resinous or pointed. Cones mostly in clusters of four, but sometimes solitary or in pairs, and only produced on the main stems, of a long, conical shape, nearly 6 inches in length, and from 2 to 2½ inches in breadth, the outer surface curved, the inner straight, widest near the base, and gradually tapering to the point, quite sessile, and uneven-sided at the base, very hard, of a light-brown colour, or silvery grey when old, very glossy, and full of resinous matter: they stand off at nearly right angles when old, although rather pendulous when young, and remain on the trees for years without even opening or shedding their seeds.

1089. *Geography.*—This tree was first discovered by Dr Coulter to the south of Monterey, near the level of the sea, and growing almost close to the beach, intermixed with other pines—chiefly *P. radiata.* Mr Hartweg found it growing on the Santa Cruz Mountains, sixty miles to the north of Monterey by land. It was introduced into Britain about the year 1847.

1090. *Description of tree.*—This is a tree of slow growth, and seldom attains more than 40 feet in height, with stems from 10 to 12 inches in diameter. While young the tree is handsome, and clothed with pretty green foliage, but when old it has a gnarled and rather deformed aspect. It begins to bear cones at a very early age, which at first are produced only on the main stem. The cones adhere to the tree for a long time. Jeffrey found trees with as many as 20 whorls of cones on the trunk, the growth of as many years; and the branches were covered with cones in the same way as the trunk. As the tree grows older, the branches, as well as the leading shoot, begin to bear cones; and as they do not fall off, but may be seen rotting on the stem and branches, even when the tree has a girth of 3 feet, the appearance of the tree is then very peculiar, being, as it were, covered with cones. It is quite hardy, and in all respects suited to grow in the climate of Britain.

1091. *Economic uses of timber.*—The timber of this species is said to be red and hard; but further than that, we cannot speak on this branch of the subject. It may be remarked here, however, that the species is not likely ever to become of any economic value in Britain, as it is of too slow a growth. Its place with us is therefore only as a peculiar specimen among other pines in a pinetum or park, or on the sides of roads in our plantations, where its cone-bearing property will always give it an aspect peculiar to itself among trees of an opposite tendency.

1092. *Soil and situation.*—Judging from the growth of the specimens we have seen of this pine, we should say that it succeeds best on a light loam, deep and dry, and on a rather low-lying part of the country.

1093. *Propagation and culture.*—Same as *P. Jeffreyii.*

1094. At various places this species is to be found of heights ranging from 20 to 30 feet.

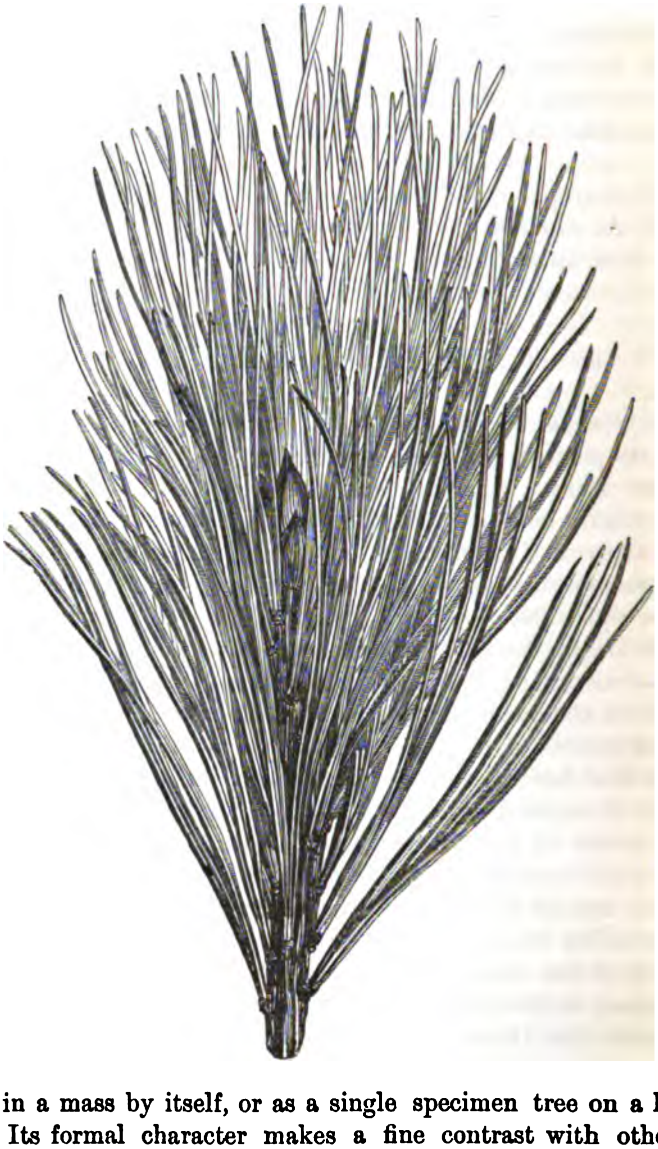
SECTION XXIX.—PINUS CEMBRA, OR SIBERIAN PINE.

1095. *Specific character.*—Leaves in fives, from 2 to 3 inches long, sharp-pointed, 3-ribbed, one of them green and shining, and the other two white. Sheaths deciduous (see fig. 117). Buds broad, globose, with a long narrow point, whitish, without resin, and mostly solitary at the end of the shoot. Cones about 3 inches long and 2½ inches broad, ovate, erect, and of a violet colour. Seeds very large, wingless, and edible.

1096. *Geography.*—The *Pinus cembra* is indigenous to Siberia, Tartary, Switzerland, Italy, and some parts of France. It is said to be found on the mountains of Switzerland at a greater height than any other species of conifer. It is found plentifully on the Alps of Hungary and Austria. It was introduced in 1746.

1097. *Description of tree.*—This is perhaps one of the hardiest of all the species of pine introduced into Britain, and is very readily distinguished from the others by its erect habit of growth, the shortness of its annual shoots—they very seldom exceed 12 inches—and by its branches being regularly disposed in whorls from the bottom to the top of the stem. It is of slow growth at all stages, and even when young, in the generality of soils, we have seldom seen it advance more than 10 inches in any one year; so that from this it is not generally much planted as a timber-tree. This cannot be said to be a tree of an ornamental character in itself; still, when properly placed among other trees in a park, its effect is striking in combination with pines and other trees of a spreading habit of growth; and for this reason it deserves a place in any park scenery. The slowness of the growth of this tree makes it unsuited to be planted among other pines and firs in a plantation, as in a few years it gets choked up when standing with trees of a more rapid growth. Its place, therefore, is to be planted as a nurse to slow-growing hardwoods, in a mass by itself, or as a single specimen tree on a lawn or park. Its formal character makes a fine contrast with other trees when it is found standing on the sides of roads in a plantation, and in this situation it suits well.

Fig. 117.



1098. *Economic uses of timber.*—The timber, when matured, is said to be of fair quality, but rather soft. Of course in this country we have no experience of its qualities, but it is said to be much used on the Continent for wainscoting and joinery purposes, as it is of a light-brown colour when matured. In the countries where this tree abounds, the inhabitants live much on the seeds as an article of diet —many of the poorer classes often having little else for their winter's food.

1099. *Soil and situation.*—The *P. cembra* is by no means particular as to soil and site, as it will grow on most parts where the Scots pine succeeds. Still, to grow it to good size, and as quickly as possible, it must be planted on a good, deep, rather light soil, which ought to be dry, and the situation not too high lying or exposed.

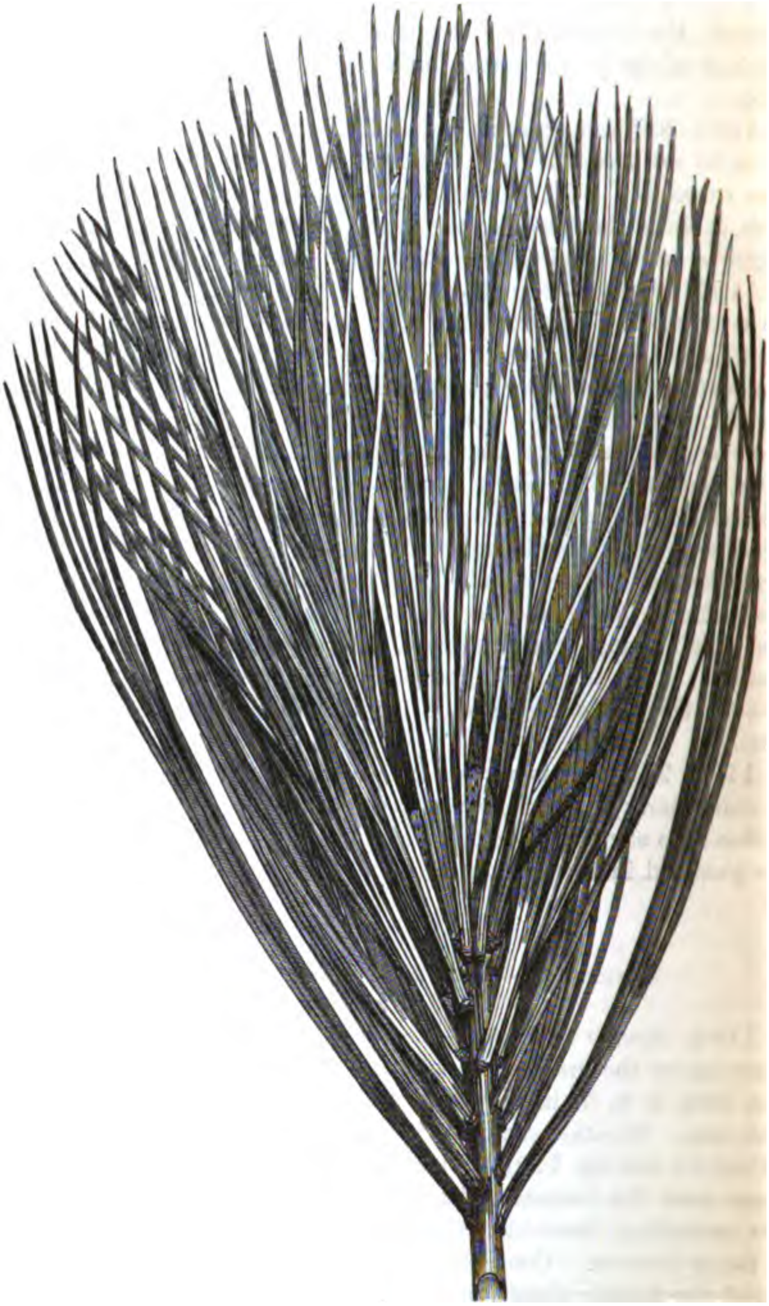
1100. *Propagation and culture.*—The seeds of this species should be sown at once after they are gathered, as if not, they will not come up till the following year. When they have become dry by keeping, the best way is to cover them with damp sand, and allow them to remain over summer. They should be sown the following spring, however, and not later than the month of March. As the seeds are large, they should be sown thinly, and covered with three-quarters of an inch of fine earth. The plants are very easy of culture, as they are always well fibred, and therefore easy to manage in the way of transplanting. They should have two summers' growth in the seedbed before removal into the nursery-lines, as even then they will be but small things comparatively, After standing two years in the nursery rows, they will not generally exceed one foot in height, and at this stage they should be planted out into their permanent sites.

1101. This pine is so well known and so common, that we think it unnecessary to refer to any particular place for specimens of it: suffice it to say that specimens of this pine, from 30 to 50 feet high, are plentiful in the country.

SECTION XXX.—PINUS EXCELSA, OR THE LOFTY PINE.

1102. *Specific character.*—Leaves in fives, long, three-edged, very glaucous on the inner faces, bluish green, and rounded on the outer one, from 5 to 7 inches long, very loose and slender, and mostly drooping. Sheaths short at first, but soon rolling up, and finally falling off (see fig. 118). Branches in regular whorls, and spreading, those near the bottom reflected, while the upper ones are more or less ascending; branchlets slender, long, and spreading; male flowers in dense clusters. Cones solitary, or sometimes two or three together round the leading shoots, of a cylindrical or somewhat conical shape, from 6 to 9 inches long, and about 2 inches broad near the base, tapering towards the point, and with a foot-stalk nearly 1 inch long;

Fig. 118.



when young of a pea-green colour, and somewhat erect, but when fully grown completely pendulous, and of a pale-brown colour, full of resinous matter in the shape of transparent drops.

1103. *Geography.*—This species is from the Himalayas, where it is found plentifully along the central range, extending east to Bhootan, west to Kafiristan, at elevations of from 5000 to 10,000 feet, attaining heights of from 100 to 150 feet. It was introduced into Britain in 1823.

1104. *Description of tree.*—This species has a very close resemblance to the American species *P. strobus*, but is readily distinguished from it by the leaves, these being very much longer on the *P. excelsa* than on the *P. strobus;* and, besides, the cones of the former are much thicker than those of the latter. The *P. excelsa* forms an open spreading-branched tree, of a somewhat conical shape, and is in all respects ornamental, and should be planted freely in Britain, as it is perfectly hardy. It is a very rapid-growing pine, but is impatient of high winds and storms. In moderately sheltered parts of the country, however, it stands well, grows rapidly to height, and is not affected by the frosts of our climate. It grows best when planted in a mass, either by itself or among larch, in a plantation of that tree. We have seen this species thriving well in such a position, on sites nearly 1000 feet above the level of the sea. When the tree stands alone it is apt to get broken with winds; but when in a mass it is supported on all sides, and grows up rapidly.

1105. *Economic uses of timber.*—The timber of this species is said to be soft, even when matured. It is white, but remarkably compact, and is said to produce in abundance a highly-fragrant resinous turpentine. Of course we are not prepared to say what the timber produced in this country is likely to be in its qualities, as we have no specimens of it old enough to enable us to judge on this point.

1106. *Soil and situation.*—This pine is not particular in regard to soil and situation, as we have seen good specimens of it in most kinds of soils, and on sheltered as well as exposed sites. To grow it well, however, it requires an open light land, dry and deep, on a moderately sheltered part of the country. It likes free air and light, and does not stand being crowded among other trees; therefore, when grown in a plantation, the trees should be given ample room, as if they have not, they will become drawn up and slender in a very short time.

1107. *Propagation and culture.*—Seeds of this species are now comparatively plentiful. They should be sown on light well-prepared soil, and dealt with in the beds as recommended for the sowing of the Scots pine. The plants are of easy cultivation, and in the nursery-rows soon become large enough for planting out.

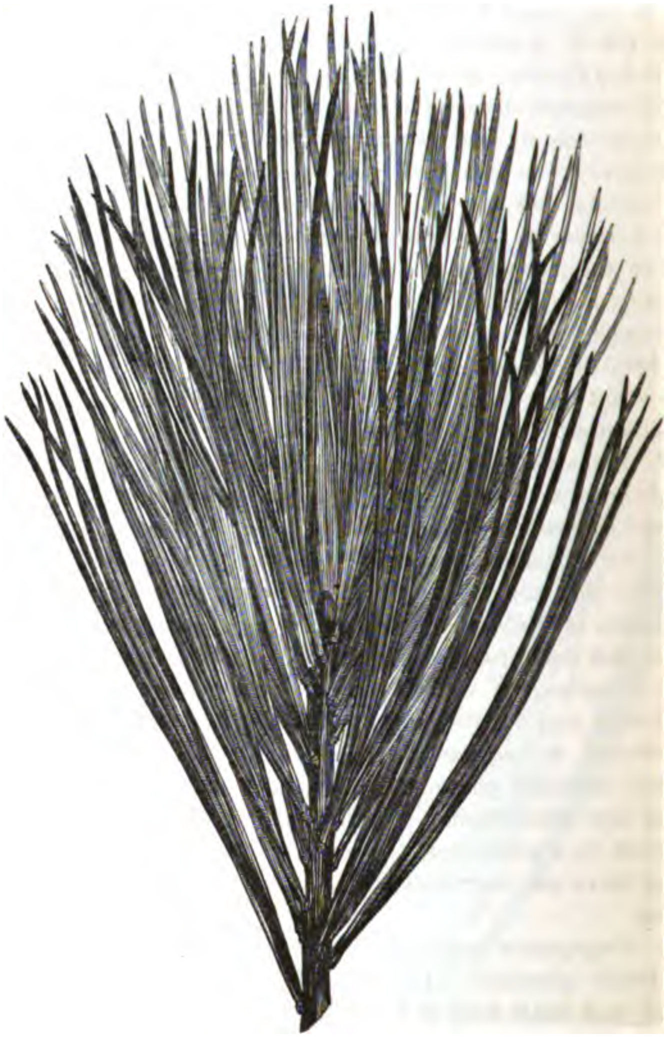
1108. This pine is now plentifully distributed over most parts of

England, Scotland, and Ireland, and specimens of it are common from 40 to 50 feet in height.

SECTION XXXI.—PINUS LAMBERTIANA, OR LAMBERT'S PINE.

1109. *Specific character.*—Leaves in fives, 4½ inches long, rather stiff, of a dull but not shining green colour, rather rough at the edges, and slightly glaucous when young. Sheaths very short, or nearly wanting on the old leaves (see fig. 119). Branches in whorls, num-

Fig. 119.



erous, and rather pendulous towards the extremities, and densely clothed with foliage. Cones very large, from 12 to 16 inches long, and about 4 inches in diameter, deep brown, cylindrical, tapering to the point, mostly straight, and destitute of resinous matter, pendulous when full grown, although nearly erect when young. Seeds large, oval, ⅞ inch long, and with the wing 1¾ inch long, and dark brown: they require two years to ripen, are pleasant to the taste, and are used for food by the Indians.

1110. *Geography.*—This species is a native of the northern parts of California and of north-west America, and is found growing intermixed with other pines and firs, and generally one hundred miles inland from the sea. In its native habitat it is said to attain its greatest dimensions of timber when growing on pure sand. It was introduced into Britain by Douglas in 1827.

1111. *Description of tree.*—This species attains large dimensions in its native parts, being found growing from 100 to 200 feet high, with stems from 7 to 15 feet in diameter near the ground, and having an open and pyramidal head of branches spreading out over a clear stem of some 60 to 100 feet. From the specimens we have of it in this country, it seems an open-headed, spreading-branched, free-growing tree, having nothing characteristic or remarkable about it. One thing, however, which is a great recommendation to it, is its perfect hardiness. We have never seen any plants of this species at all injured by the frost of our climate.

1112. *Economic uses of timber.*—The timber of this species is said to be white and soft; and more than this we will not be able to say till there are trees large and old enough in this country to enable us to judge for ourselves.

1113. *Soil and situation.*—The *P. Lambertiana* does not appear to be very particular in respect to soil, as we have seen good specimens of it on poor gravelly land, on a light peaty soil, on a light and on a heavy loam, and even on a clay soil. If the land on which it is planted be dry and of an open bottom, it will succeed on a great variety of soils. Our experience of the tree leads us to say that it does best on a light loam, not rich, but rather poor, and on a site exposed to free light and air.

1114. *Propagation and culture.*—The seed of this pine may be sown on any well-prepared piece of ground in the usual way, as it vegetates freely, and the young plants require no protection whatever.

1115. At many places in England and Scotland there are fine healthy specimens of this pine that have attained heights of from 35 to 45 feet.

SECTION XXXII.—PINUS MONTICOLA, OR THE MOUNTAIN-PINE.

1116. *Specific character.*—Leaves five in a sheath, short, smooth, and blunt-pointed, from 3 to 4 inches long, rather 3-sided, slender, glaucous-green, and with a silvery appearance when young. Sheaths short and imbricated. Cones long, cylindrical, 6 to 8 inches long, and about 1¾ inch wide, tapering to rather a blunt point, smooth, and full of resin, generally in whorls, and on short foot-stalks. Branches rather stout, short, and densely clothed with foliage.

1117. *Geography.*—This pine is found abundantly in northern California on Trinity Mountain, at an elevation of about 7000 feet, growing on granite rock, on a very poor soil; and on the still higher mountains at the Grand Rapids of the Columbia, and on the rocky banks of the Spoken River. It was introduced into Britain in 1831.

1118. *Description of tree.*—This forms a very handsome tree, being well clothed with foliage, while the branches present a fine irregular outline. It is said to grow to a large size in its native parts; and, judging from its rate of growth in this country, we are quite prepared to believe it does. It is very hardy, too, which is a great recommendation to it, and deserves a place in every park and pinetum, where its dense foliage is calculated to produce a good effect among trees of a more open habit.

1119. *Economic uses of timber.*—The timber of this pine is said to be of a white colour, fine-grained, and tough.

1120. *Soil and situation.*—This tree thrives well on most kinds of land. We have seen good specimens of it on a very light and gravelly soil, and also on soils of quite an opposite character. It seems a hardy tree, and accommodates itself to a great variety of soils, provided they are deep, porous, and dry. It stands well in an open airy site, but does not thrive well if exposed to frequent storms.

1121. *Propagation and culture.*—The seed of this species is still scarce. The plants come up perfectly well when it is sown on the open ground in the usual way, but from the scarcity of plants of the species in the country, cultivators usually protect them with a frame during the first winter after they have come up—more, however, from a fear of losing any of them, than from the plants really requiring protection.

1122. There are now many fine specimens of this tree in various parts of the country, of heights varying from 40 to 70 feet. We may add that the specimens at Dropmore in England, and those at Keir in Scotland, are the best we have seen of this species.

SECTION XXXIII.—PINUS MONTEZUMÆ, OR MONTEZUMA'S MEXICAN PINE.

1123. *Specific character.*—Leaves in fives, from 3 to 4 inches in length, but on young plants often from 4 to 5 inches long, rather stout, rigid, 3-edged, and rough at the angles, thickly set on the young branches, and supported by long, sharp-pointed, brown scales at the base of each sheath, of a dark green on the upper surface, and slightly glaucous on the under side on the young leaves, but on old full-grown leaves dark green on both sides. Sheaths persistent, or not falling off, nearly ½ inch in length, and rather rough or jagged on the ends. Branches few, very irregular, rather stout, and twisted. Bark very rough, particularly on the young wood, which is covered with numerous long, broad, sharp-pointed scales. Buds few, imbricated, non-resinous, and rather lengthened. Cones in clusters of three or four together, but frequently single, nearly horizontal, from 4 to 6 inches in length, and 1¾ inch broad at the widest part, which is near the middle, then tapering to both ends, and slightly incurved, but especially towards the point, which is rather small.

1124. *Geography.*—This pine is found plentiful on mountainous districts in many parts of Mexico. Hartweg found it on the mountains of Mexico, near Ajusco, forming a tree 40 feet high. It is also found on the mountains of Orizaba, at an elevation of some 11,000 feet, growing from 40 to 60 feet high. It was introduced into Britain in 1826.

1125. *Description of tree.*—This species does not attain great height or dimensions of stem, and may be characterised as a spreading-headed, thin-branched, and rough-barked pine, worthy of being cultivated only as a variety in a pinetum.

1126. *Economic uses of timber.*—The timber of this pine is said to be resinous and good; but in Britain it is not wanted for its timber, as we have many other pines much superior to it in this respect.

1127. *Soil and situation.*—Although, in a general way, this species may be said to be hardy in this country, still it has been found very fastidious in regard to soil and site; and we must say that, so far as we have experienced its habits, it requires a good light loam, in as sheltered and favourable a situation as can be given it.

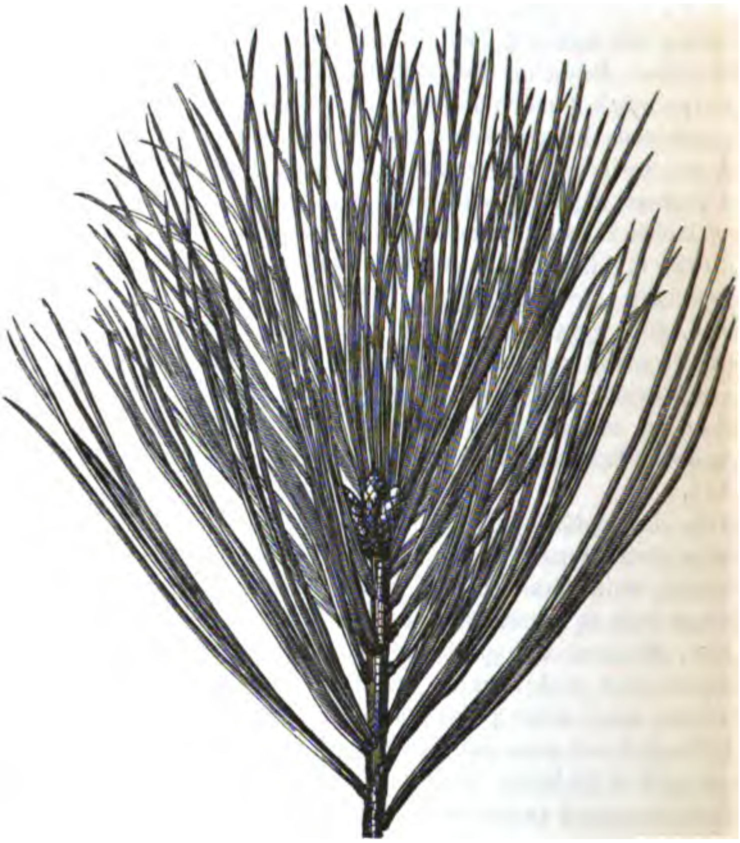
1128. *Propagation and culture.*—Young plants of this species require to be protected by a frame during the first winter or two, till they have formed perfect wood and leaves.

1129. As we have not had returns in regard to specimens of this pine, we are not prepared to state the sizes at which they are now to be found in the pinetums of Britain.

SECTION XXXIV.—PINUS STROBUS, OR WEYMOUTH PINE.

1130. *Specific character.*—Leaves five in a sheath, very slender, 3 to 4 inches long, 3-sided, soft, and of a light-glaucous or bluish-green colour, marked when young with silvery channels on one side. Sheaths very short, almost wanting, and soon falling off (see fig. 120). Branches short, in whorls, thinly clothed with foliage, and having a smooth shining bark. Cones long, narrow, lax, slightly curved, cylindrical, tapering to rather a sharp point, and pendulous, from 5 to 6 inches long, and from 1¼ to 1½ inch broad, with a footstalk ¾ inch long.

Fig. 120.



1131. *Geography.*—The Weymouth pine, or white pine, as it is often named, is indigenous to Canada, and to all the Northern States of the American Union, and it forms the principal bulk of the pine timber imported into Britain from America. We have ourselves found this tree plentiful in most parts of Canada, and especially in the valleys of the rivers Ottawa, Madawaska, and Gateneau, where large quantities of it are felled every year and floated down to the St Lawrence, where it is shipped for Europe. It was introduced into Britain in 1705.

1132. *Description of tree.*—In its native habitats this pine grows to very large dimensions. We have measured many of them as they lay felled on the ground; and, taking a number of them, we found the stems average 150 feet long by 2 feet 9 inches diameter at 5 feet up from the bottom. This may be taken as an average of the size of the trees as they stand in their native parts; but we have found many of them that measured 210 feet long, with stems from 5 to 7 feet in diameter at 4 feet up from the bottom; and on counting the annular layers on the stumps from which they were cut, we found them to range between 350 and 425, which may be taken as representing the years of their age. In the natural forests we very seldom found this tree on a sandy soil, but generally on gravelly ridges and knolls, as a crop by itself, and on dry rich lands, intermixed with beech, lime, maple, and other hard-wooded trees. In the latter situation we have invariably found trees of the largest size. This pine has generally a stem free from branches for at least two-thirds of its height, and the branches are never of large dimensions, nor do they extend far out from the stem: even in the case of trees about 200 feet high, the branches seldom extend more than 20 feet out on either side, and are always arranged in whorls, with clear spaces between. On young trees the bark is very smooth, and the leaves longer than on old trees, having very much the appearance of *P. excelsa.* As the tree becomes old, however, the bark becomes rough, and on matured specimens it is rugged, and of an ash-grey colour, but it never scales off like the bark of many pines. When grown singly, the *P. strobus* forms a handsome tree; but in order to this it requires shelter from other trees around it, as in this country it will not prosper on an exposed site. It is a tree well worthy of a place in any park in Britain, as, if on a favourable soil and site, it attains very respectable dimensions, especially in England. Even in Scotland we have felled trees of this sort from 60 to 70 feet high, and containing upwards of 40 feet of timber.

1133. *Economic uses of timber.*—The timber of this species is more used in America than that of any other pine. The most of country houses are built with it, where it abounds; and in the towns the woodwork of the houses is chiefly made from it. Indeed there are few purposes to which wood is applied in America for which it is not used. Even in Britain the imported timber of this species enters largely into the construction of our houses, and many other erections.

It is not, however, so durable as the red-pine timber from the Baltic, being softer and more liable to dry-rot.

1134. *Soil and situation.*—To grow this species well in Britain, it requires to be planted on a good, deep, dry, and light loam, and in a somewhat sheltered situation. We have seen it do well on dry sloping banks among other trees, where it had room to spread out its branches, and still sufficient shelter to protect it from prevailing storms. In America we have found it growing on most descriptions of land, but seldom on sand or on heavy clay soils. The best quality of timber we have always found on gravelly knolls and ridges.

1135. *Propagation and culture.*—This tree, like all others of the tribe, is raised from seeds, which are generally ripe in this country about the end of October. The cones are easily opened, and the seed extracted from them. When the cones are gathered and the seed taken from them, it should be sown about the 1st of April, and dealt with in every respect as recommended for the rearing of the Scots pine.

1136. Of this species there are many fine timber specimens in various parts of the country, north and south. For example: at Dropmore the tree is over 70 feet high, with strong proportionate stems; while at Kew it is of similar proportions; and in other parts of England there are specimens even larger—such as that at Longleat, where it is over 90 feet high, with a stem above 3 feet in diameter. In Scotland as well, the tree forms respectable dimensions as timber.

SECTION XXXV.—PINUS HARTWEGII, OR HARTWEG'S PINE.

1137. *Specific character.*—Leaves in fives, but frequently in fours, very dense, 6 to 7 inches long, rather slender, curved, and of a dark-green colour. Sheaths long on the young leaves, but with a shrivelled appearance on the old ones, and jagged at the ends. Branches few, very robust, and irregularly placed on the stem. Cones growing in clusters, pendulous, 4 to 6 inches long, and nearly 2 inches broad, oblong, tapering to the point, which is rather blunt, incurved, and of a dark-brown colour.

1138. *Geography.*—This species was found by Mr Hartweg on the Campanario Mountain in Mexico, at an elevation of 9000 feet, and beginning to appear where the *Picea religiosa* ceases to grow on the mountain. It is found also on the mountains of Orizaba, and near Real del Monte, at an elevation of 10,000 feet, and 100 feet high. It was introduced into Britain in 1839.

1139. *Description of tree.*—This is a very handsome tree, growing fully 50 feet high, with a dense, compact head, of a fine dark-green-coloured foliage. It is a very robust branched tree,—indeed this forms a striking feature in its habit; and it may be readily distinguished from most other pines by the very strong appearance of its shoots, and its long slender leaves give these a peculiar effect. It is hardy enough for favourable localities in Britain, and is deserving of a place in our pinetums.

1140. *Economic uses of timber.*—This species does not seem to be of any value as a timber-producing one in this country, although it is stated to produce excellent timber in its native climate. There the timber is said to be very durable, containing much resinous matter. We have no hope, however, of its ever becoming valuable in this way in Britain. Its place with us seems to be in ornamental planting only, for which purpose its character is well suited.

1141. *Soil and situation.*—This species requires to be planted on a rather poor and light loam, where it has free air and light. If planted on a rich soil, its growths are liable to be of a soft and half-prepared description, and therefore to be injured by frost.

1142. *Propagation and culture.*—Although this species of pine is hardy enough for growing on the more favourable parts of Britain, still the plants are tender when young, and, like those of the *P. halepensis* and some others, require the protection of a frame for the first two winters after coming up.

1143. Specimens of this species are not plentiful in the country, but there are specimens from 20 to 25 feet in height at Kew and at Castle Kennedy.

SECTION XXXVI.—THE FIR (ABIES)—LINNÆAN SYSTEM, MONŒCIA MONADELPHIA.

1144. *Character of the genus.*—Male catkins axillary or terminal, the female ones terminal and solitary. Cones pendent, solitary, terminal, and persistent for a long time. Scales persistent, leathery, thin, broadly rounded, and sometimes undulated on the edges. Seeds oblong, pointed, with a short, stiff, deciduous wing, and bony shell. Bracteas small, and hidden by the scales, or long and trident, like the Douglas fir. Seed-leaves from 7 to 9 in number. Leaves solitary, 4-sided, acute-pointed, and scattered all round the shoots, or flat and more or less 2-rowed, like the hemlock spruce.

1145. The firs are all evergreen trees, natives of Europe, Asia, and America, and are remarkable for their tall, erect, pyramidal forms, and dense foliage. In Britain they flower in May and June, and ripen their cones in the spring of the following year. All the species bear seeds at a very early age, and all of them may be readily propagated by cuttings taken off in the spring or in autumn, as in Britain is generally the practice by cultivators of some of the rare species.

1146. This is also a very valuable genus of trees, and is easily distinguished from the pine by the tall pyramidal form of its species, by their more rapid growth, and by the comparative weakness of their branches, which seldom attain timber size, and which gradually die off as the trees grow old. But besides this characteristic, the trees of the Abies family are still more readily distinguished from those of the pine by the disposition of their leaves on the branches. In the pines the leaves grow from the shoots two or more in a sheath (see fig. 121), while in the firs the leaves grow singly, and are scattered chiefly on the upper sides of the branches (see fig. 121 *b*).

1147. The fir is a tree that generally attains maturity much earlier than the pine, and seldom lives long after arriving at its maturity.

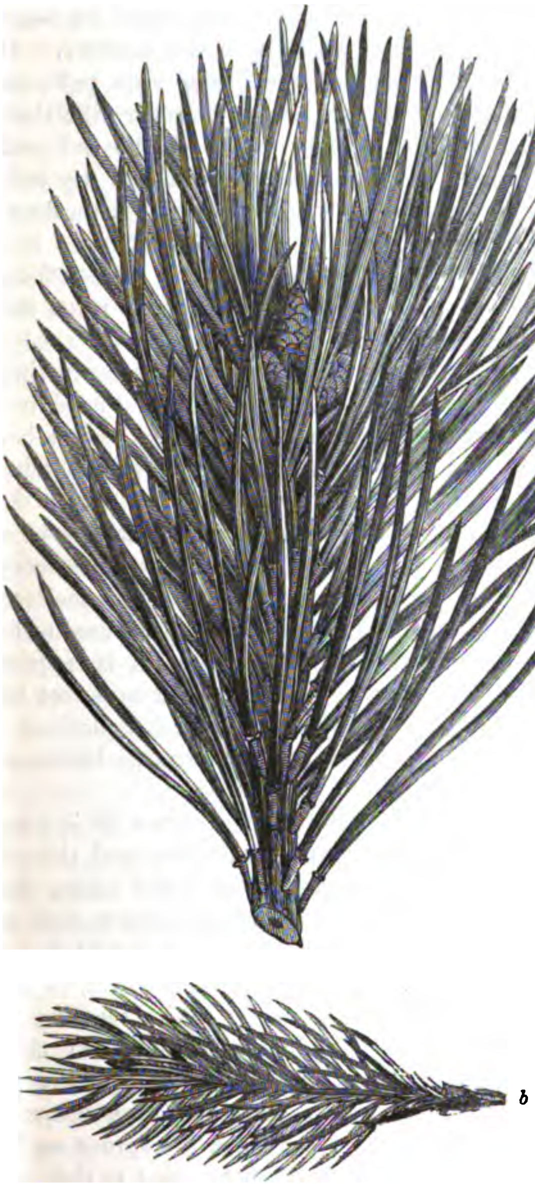
SECTION XXXVII.—ABIES EXCELSA, OR NORWAY SPRUCE FIR.

1148. *Specific character.*—Leaves scattered, solitary, 4-sided, deep green, curved, stiff, sharp-pointed, and more crowded together laterally than on the upper and under sides, and nearly 1 inch long. Branches on young trees nearly horizontal, and disposed in regular whorls from the base to the summit; but on old trees the bottom branches drop off, and the others become rather pendulous. Cones produced on the points of the upper branches, and when full grown become pendent, from 5 to 7 inches long, and 1½ to 2 inches in breadth.

1149. *Geography.*—The common Norway spruce fir is indigenous to the hills and mountains of Europe and Asia, in places where the soil is moist, and the atmosphere cold and humid. It is, however, most common in Norway, Sweden, Lapland, Denmark, and the north of Germany. It is also found on some of the mountainous districts of France, on the Alps, the Pyrenees, and in Switzerland. It was introduced into Britain in 1548.

1150. *Description of tree.*—The Norway spruce fir is one of the tallest of the European coniferæ, in its native countries frequently rising to a height of 150 feet, with stems from 4 to 5 feet in diameter; and even in Britain it is not unusual to find specimens above 100 feet in height, with diameters of stem between 2 and 3 feet. It grows in a peculiar pyramidal form. The stem rises like a perpendicular stalk, clothed with proportionally small feathered horizontal branches from bottom to top. These, when the tree stands free and alone, gradually become smaller and shorter as they are found high upon the tree, thus giving the tree almost a perfect cone shape. In young trees the branches generally stretch out horizontally, but in old ones they droop a good deal, giving the tree

Fig. 121.



a very graceful appearance. The tree is nearly as hardy in Britain as the Scots pine is, only it does not succeed on high-lying sites if the soil be thin and dry; but in low-lying situations, and even in high-lying ones, where the soil is favourable, it is as hardy as any tree we have.

1151. *Economic uses of timber.*—The timber of the common spruce is, next to that of the *P. sylvestris*, the most useful for boards, planks, and roofing scantlings which we have in this country. It is of excellent quality when of mature age, being very light and pliable. The quality of the wood of this tree is, however, like that of the *P. sylvestris*, much influenced by the nature of the soil and situation upon which it is grown. When grown on a thin dry soil, the wood is brittle and short-grained; but when grown upon a deep and cool-bottomed loam, it is quite of an opposite character. In its young stages the spruce fir yields a far more durable timber than the Scots pine at the same age; but the case is the reverse when the trees are old and their timber matured.

1152. *Soil and situation.*—This tree is naturally inclined to grow in what may be termed a cool and moist-bottomed land, and in Britain it is found to succeed best in a low-lying and rather sheltered part. Indeed, upon a high site, if much exposed to cutting winds, it seldom attains anything like a respectable timber size in this country,—more especially if the soil upon which it is planted be of a dry, thin, sandy, or gravelly nature, the tree generally becomes rotten at heart before it arrives at anything like a useful size. In sheltered hollows, with good deep cool-bottomed soil, the spruce attains its best dimensions in this country, and in such situations it is frequently found from 80 to 100 feet high, with stems from 2 to 3 feet in diameter. The spruce fir grows well on moss-land, after it is drained and excess of moisture removed. The tree likes a cool moist-bottomed land, but not wet.

1153. *Propagation and culture.*—The spruce fir is propagated in exactly the same manner as the *P. sylvestris*, and the observations given regarding the gathering of the cones, and taking out and sowing the seed of it, are in every respect applicable to this tree, except that in the present case the seed is ripe and should be gathered in the early parts of spring. The spruce fir, however, is much slower in growth than the *P. sylvestris* while in its seedling state. The seedling plants remain two years in the seed-bed, but they generally require three years in the nursery-rows before they are fit to be put into their final situations in the forest, or even more if they are wanted of large sizes. Many recommend the spruce as being a good nurse for hardwood trees, but we cannot assent to this opinion. So far as our experience enables us to speak on the subject, we must confess that we have found the larch and Scots pine far superior for this purpose. Besides its being of too rapid growth for hardwoods, it has the disadvantage of having very fibrous and matty roots. Now these, from their matted closeness, keep the air and heat from penetrating properly into soil for the benefit of the hardwoods, which send their roots deeper down, consequently much injury is often done by this means. The spruce fir, as also all the coniferous tribe, are best suited for timber when planted in a mass by themselves; but seeing that it is proper, and even necessary, to have a proportion of them planted for the benefit of nursing up our hardwood plantations while in a young state, we in all cases recommend planting the spruce but sparingly for that purpose, having found the Scots pine and larch answer very much better.

1154. Good specimens of this fir are plentiful in most parts of Britain, and therefore it is unnecessary to refer to them as found on any particular place. Suffice it to say that trees from 80 to 110 feet in height, with stems from 2 to 3 feet diameter, are common in many parts.

SECTION XXXVIII.—ABIES CANADENSIS, OR HEMLOCK SPRUCE FIR.

1155. *Specific character.*—Leaves solitary, flat, and irregularly disposed in two rows, from ½ inch to ¾ inch long, downy when young, rough at the margins, blunt-pointed, bright, vivid light-green on the upper surface, and with two silvery stripes underneath on each side of the mid-rib. Branches numerous, slender, and downy when young, spreading, and rather flat. Cones pendulous on the extremities of the branches, from ⅝ inch to ⅞ inch long, and from ⅜ inch to 4/8 inch broad, of an oval shape, green when young, but brown when ripe. Bark smooth, and of a light colour.

1156. *Geography.*—The hemlock spruce fir is found nearly all over Canada, and in the greater part of the northern and eastern states of the Union. We have found it very plentiful in the Canadian woods, from Quebec on the one hand, westwards to Lake Huron on the other. Indeed there is no tree more plentiful in the forests of Canada, and it is generally found occupying banks on the sides of rivers and edges of swamps: sometimes, however, it is found on dry lands as well, but in such cases the trees are smaller than when found on a cool moist-bottomed land. This species was introduced into Britain in 1736.

1157. *Description of tree.*—This is one of the handsomest trees found in the American woods. In its young stage, say when under forty years old, the tree is of a remarkably graceful habit, from the uniform disposition of its then somewhat slender branches all round the stem, which are invariably of a drooping habit at the ends, and thickly clothed with their light-green leaves. As it becomes older, however, and approaches maturity, the branches become larger and stronger, and stand out horizontally, giving the tree very much the character of the cedar of Lebanon in that respect. In the American woods, where the trees of this species are seen in perfection at all stages of growth, they present very varied outlines, according to their age. In the Canadian woods it is not uncommon to find trees of this sort over 100 feet high, with stems from 4 to 5 feet in diameter. This tree has been much neglected in British arboriculture, and we here recommend landed proprietors to use it more than they have done for ornamenting their home parks, as few trees are more graceful and ornamental than it is, not only when young, but when old as well; and it is well known to be perfectly hardy in Britain, although requiring a sheltered site to grow well in.

1158. *Economic uses of timber.*—The wood of this tree is not at all valuable, even in the parts where it attains its greatest dimensions. In America it is used only for rough planking, and never for any purpose requiring strength and durability. The tree, however, is very valuable for its bark, which is used all over Canada for the tanning of leather.

1159. *Soil and situation.*—This tree likes a deep and somewhat moist soil, and in all cases a sheltered situation. The largest and handsomest specimens we saw in the Canadian woods grew on land, light, deep, and rich, with a moist and cool bottom.

1160. *Propagation and culture.*—This tree is propagated from seeds, which are, or may be, imported in abundance from America. When received, the seed should be sown on a sheltered part, and on a fine light soil, in April,—and as they are small, they should be covered slightly. They should stand two years in the seed-beds before they are planted into the nursery-rows. They may stand in the rows for two, three, or four years, according as the plants may be wanted large or small; but if they are wished of a large size before planting them out, they will require to be frequently transplanted in order to increase the fibrousness of their roots, as otherwise they would not transplant safely of a large size.

1161. Specimens of this fir are plentiful in most parts of the country, many of them having attained heights of from 35 to 60 feet

SECTION XXXIX.—ABIES NIGRA, OR BLACK SPRUCE FIR.

1162. *Specific character.*—Leaves solitary, regularly spreading all round the branches, and somewhat 4-sided, erect, straight, and stiff, ½ inch long, thickly set, and of a dark-green colour. Branches horizontal or very slightly drooping at the ends in old trees. Cones pendulous, egg-shaped, ¾ inch to 1½ inch long, and from ⅝ inch to ⅞ inch broad, deep purple when young, but when ripe of a reddish brown.

1163. *Geography.*—This tree is a native of the Northern States of America and of Canada, and is very abundant on cold-bottomed lands in the province of Lower Canada, where it forms large forests intermixed with the hemlock spruce. We have found it plentiful on a great variety of soils in the valley of the Ottawa, intermixed with *Pinus strobus* and various hardwood trees. It was introduced into Britain in 1700.

1164. *Description of tree.*—On deep cool-bottomed lands this tree attains a great height, frequently from 80 to 100 feet; but we have seldom seen the stems, even of the tallest specimens of it, more than 24 inches in diameter. Generally speaking, it forms a tall slender tree, with branches spreading horizontally, and frequently drooping at the ends in the case of old trees. The stem is generally smooth, with a blackish bark, very straight, and diminishing regularly from the bottom to the top. The whole tree has an open and airy appearance, from light being admitted between the whorls of branches, which are never of a massy or heavy character, like those of the common spruce fir, but light and pointed, each tier showing its outline distinctly. The tree is well worthy of a place in any park or lawn, as its light spiral form and dark-coloured foliage contrast agreeably on well-chosen sites with trees of a flat and denser habit, and especially with those having their foliage of a light-green colour. It has always a good effect when planted along the sides of roads in a plantation of hard-wooded trees, or in one of larch, as in such situations the contrast between it and the other trees is very striking, both in summer and in winter.

1165. *Economic uses of timber.*—In America the timber of the black spruce fir is much valued for its strength, lightness, and elasticity. It is much used in house-building, and for fencing purposes, in all parts where it is abundant. The timber is considered durable, and therefore applicable to many purposes, but it is seldom found of such large dimensions as to make it available for purposes where bulk of timber is an object.

1166. *Soil and situation.*—The tree is well known to be perfectly hardy in Britain, and to grow on a great variety of soils. We have seen good specimens of it in almost all soils not too light and dry, but the best trees we have seen of it grew on a deep, somewhat mossy soil, with a cool, moist bottom. It grows on the same conditions of soil and situation as the Norway spruce fir, as, like it, it luxuriates on land having a cool bottom, and in a rather low-lying and sheltered site. It does not succeed on an exposed or on a very dry site.

1167. *Propagation and culture.*—The seed of this tree is abundant and easily procured, and in this country its propagation may be dealt with in all respects as has been stated in regard to that of *Abies canadensis*. The seeds of all the North American firs should be sown on a well-prepared, rather rich, and dry-bottomed piece of land, and on a warm site and exposure.

1168. Good trees of this species are common in the country, not only in Britain, but in Ireland as well, many of them having attained heights of from 40 to 70 feet.

SECTION XL.—ABIES ALBA, OR WHITE SPRUCE FIR.

1169. *Specific character.*—Leaves solitary, incurved, sharp-pointed, glaucous, 4-cornered, and scattered round the branches, about ¾ inch long, but frequently longer, and not very thickly set on the branches. Branches compact, and rather dense. Cones oblong-cylindrical, 1½ to 2½ inches long, and nearly ¾ inch broad at the thickest part, slightly tapering to the point, pendulous, and rather lax. When the cones are ripe, they are of a lightish-brown colour.

1170. *Geography.*—This species also is a native of the Northern States of America and of Canada, but is very much less common than the black spruce. In America we have generally found it on dry light lands, and very frequently growing along with or in the close neighbourhood of *P. strobus*. It was introduced into Britain in 1700.

1171. *Description of tree.*—This species is easily distinguished from all the other species of the family by the lighter colour of its leaves, which are of a somewhat hoary grey colour: hence its name. Even in its native sites this is not a tall tree, nor one of large dimensions in any respect. We have never met with it above 45 or 50 feet in height, nor with a stem more than 12 or 14 inches in diameter. It forms a beautiful small tree, however, being a perfect pyramid when found standing alone and unencumbered. It should be more planted in Britain than it has been—not for the sake of its timber, but as an ornamental tree in parks and lawns, and on the sides of roads in plantations, as in these situations its light colour and beautiful pyramidal habit would produce varied and agreeable effects when seen in combination with other trees in the background of darker shades and more rounded forms. In our rambles through the American forests, we have often had occasion to admire the gorgeous effect produced by this tree when seen in the autumn in combination with the dark foliage of pines and the yellow and crimson leaves of the sugar-maple. The proprietor who wishes to produce a rich colouring of foliage in any particular part of his grounds has only to plant some dark-leaved pine in the background, the sugar-maple in front of it, and the white spruce in front of the maple; and when these trees have attained some size, he will find the autumn colourings admirable—the yellow, red, and crimson of the maple, the very dark green of the pine, and the hoary grey of the white spruce, blending so as to produce an effect indescribable, and beyond the art of the painter.

1172. *Economic uses of timber.*—We have never seen the wood of this tree applied to any purpose. When in America, we found it was not valued in respect to its timber by the settlers, they in all cases preferring the timber of the black spruce or the pine instead.

1173. *Soil and situation.*—This tree grows best on dry sloping banks, where the soil is light and deep. It grows on heavy lands, but on these it never attains the same dimensions as it does on lands of a light and deep description. Like the black spruce, it likes a sheltered site, but it does not stand confinement among other trees. In the American woods, wherever we found it encumbered with other trees it was unsightly and a mere pole, but where it stood alone it was feathered to the ground.

1174. *Propagation and culture.*—These are in all respects the same as has been stated in respect to the hemlock and black spruces.

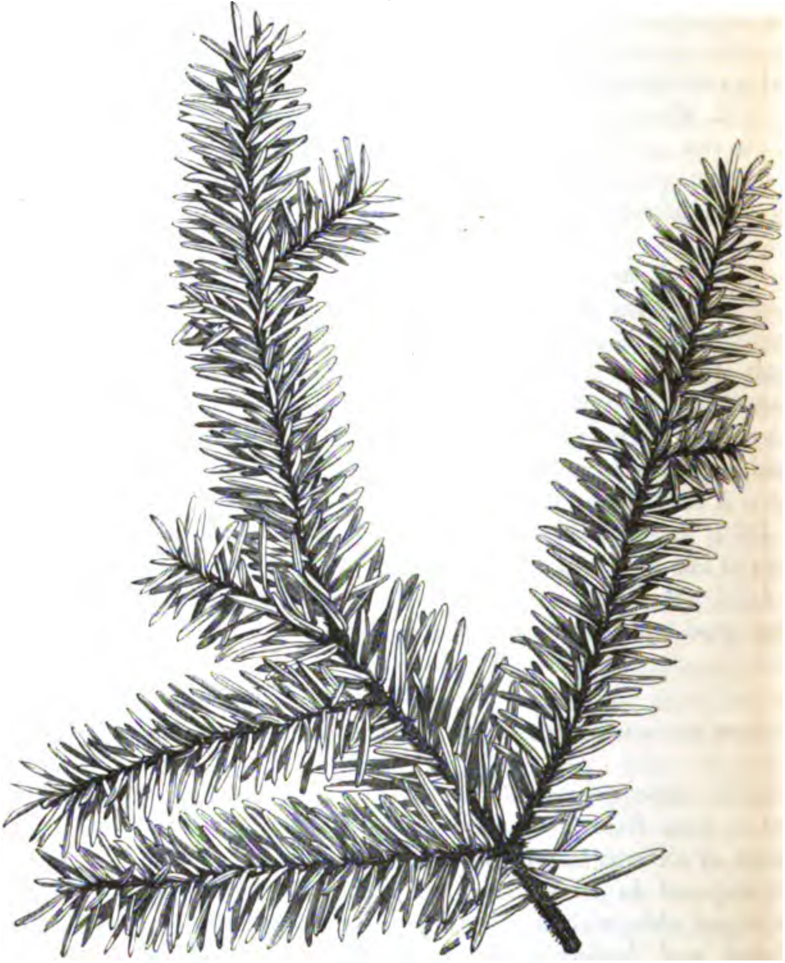
1175. At Castle Kennedy and at Hopetoun House there are some good specimens of this fir.

SECTION XLI.—ABIES ALBERTIANA, OR THE CALIFORNIAN HEMLOCK SPRUCE.

1176.—*Specific character.*—Leaves green, glaucous beneath, irregular in size, from 2-8ths to 6-8ths of an inch long, and about 1-16th of an inch broad, solitary, growing spirally round the branch, but disposed in an alternate manner, flat, slightly canaliculate on the upper side, with a mid-rib on the under one generally blunt-pointed, and having a very short footstalk, and rather thickly placed on the branchlets (see fig. 122). Branches numerous, slender, and more or less bent downwards at the ends; branchlets very slender, flexible, long, drooping, and somewhat downy when young. Cones nearly 1 inch in length, pale brown, solitary, oblong-ovate, without any footstalk, and pendulous at the ends of the shoots.

1177. *Geography.*—The seed of this tree was first sent home by Mr Jeffrey in 1851, under the name of *Abies taxifolia.* On further supplies of seed coming home, the species was examined into, and was supposed to be Bongard's *Abies Mertensiana,* and under this name it is described in Gordon's 'Pinetum,' and is still extensively known by it. It is believed to be a new species, however, and has been named in memory of the Prince Consort, and is now best known by it. This species was found in Oregon, Northern California, British Columbia, and Vancouver Island.

Fig. 122.



1178. *Description of tree.*—This tree being of comparatively recent introduction, we have no very large specimens of it from which to judge of its general character and habit. In its native parts it is said to be a fine, graceful, round-headed tree, of 100 feet and upwards in height, with a stem varying from 4 to 6 feet in diameter. Judging from the appearance and habit of the plants we have in the country, it is indeed a fine and a graceful tree, forming a dense mass of foliage on long, slender, and drooping branches. The tree very much resembles the *A. canadensis*, but is more open in its habit of branches, and certainly a much freer grower, taking a more upright and tree-like form from the first. It is found to be perfectly hardy for the climate of Britain, and has succeeded well even in Scotland,—one of the oldest specimens in the country, and perhaps one of the best, growing at The Cairnies, in Perthshire. This specimen was raised from the seed first sent home. The tree is worthy of a place in every collection, and must in time become a general favourite with all planters on home grounds.

1179. *Economic uses of timber.*—Very little can be said as to the timber of this species. Gordon says in respect to the timber, that it "is white, very soft, and yields but little turpentine." Brown says in regard to the timber of this species: "The timber is said to be firmer, finer, and straighter-grained than the Canadian hemlock spruce."

1180. *Soil and situation.*—This species does not seem to be very particular in regard to soil, as in Britain we have it growing healthily and rapidly in most soils. So far as we are able to judge of the species at present, we should say that it does best on a cool-bottomed land, similar to that referred to in respect to the *Abies canadensis*. We may mention here that we have observed it of rather a stunted habit on light and dry soils, showing that it prefers a cool loamy soil.

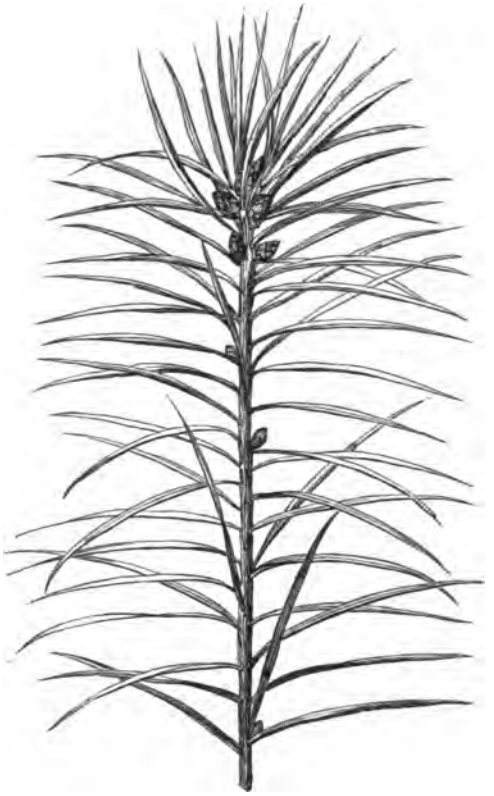
1181. *Propagation and culture.*—After the first importation of the seeds of this tree there was a great demand for it—so much so that all the plants were soon used up, and none other could be had. Seeds of it have been imported of late, however, as plants are now comparatively plentiful in the country. In the absence of seeds, a good many of the existing plants have been reared from cuttings, and in this way it is easily propagated, as all the other species are.

1182. Specimens of this tree are now common in most parts of the country, many of them having attained heights from 25 to 35 feet.

SECTION XLII.—ABIES DOUGLASII, OR THE DOUGLAS FIR.

1183. *Specific character.*—Leaves solitary, flat, entire, narrow, linear, spreading and irregularly two-rowed on the older branchlets, but on the younger ones growing plentifully along their upper side and more sparingly on the under, from ¾ to 1¼ inch long, bluntly pointed, bright green above and slightly glaucous, and much paler below (see fig. 123). Branches numerous, irregularly placed along the stem, spreading horizontally, sometimes a little ascending, very twiggy, and nearly flat. Branchlets long, slender, mostly in two rows, and more or less declining. Cones ovate or oblong, terminal at the points of the upper branchlets, solitary, pendulous, yellowish brown, with many linear, extended, sharp-pointed bracteas, loosely imbricated, from 3 to 4 inches long, and from 1 to 1½ inch in diameter. Scales rounded, smooth, leathery, concave, quite entire, thin, and persistent. Bracteas linear, three-pointed, the middle one longest and pointed, the two outer ones being comparatively short. Seeds small, with a wing fully ⅝ inch long.

Fig. 123.



1184. *Geography.*—This species is said to be very plentiful on Vancouver Island. It is found in large forests in the north-west parts of America and at different elevations on the Rocky Mountains, forming a small bush on the higher parts of those mountains, but becoming gradually larger as it is found lower down, till on the lower slopes and plains its growth attains to specimens of 150 to 250 feet high, with frequently diameters of 10 feet. Trees of the latter dimensions are said to be found plentifully on the banks of the Columbia River. It was introduced in 1826.

1185. *Description of tree.*—This is truly a noble tree, and is without doubt destined to become highly useful as a timber-producing one in our plantations, as well as it is now an ornamental one in our parks, lawns, and pinetums. Its rapidity of growth makes it a very desirable tree to cultivate. It is not much over fifty years since it was first introduced into the country, and already we have many specimens ranging from 70 to 80 and one or two even 100 feet high, with proportionate diameters of stem, all healthy and still growing rapidly, and bidding fair to become the giants of our woods. With this experience before us, we are warranted to say that the *A. Douglasii* is ere long to become a valuable tree among us, even as a timber-producing one. Its habit of growth is much in its favour as an ornamental tree for parks and lawns, as when it stands unencumbered it is feathered to the ground with branches densely clothed with cheerful-looking bright-green and somewhat silvery-looking foliage, which gives the whole tree a grand and imposing effect. Every arboriculturist should plant this tree as extensively as his circumstances will admit, in all parts of the country at all suited to its growth. It should be planted not only as single specimens for ornament, but in masses at moderate elevations for the sake of timber. As the plants are still comparatively high-priced, in making plantations of the tree they should be used on the land some 30 feet apart as the permanent crop, and made up with larch as nurses to 5 feet over all. Dealt with in this way, the larch could be thinned out as the *A. Douglasii* required room, so that in the course of twenty years or so a complete plantation of this tree alone could be secured. The tree is quite hardy on all low-lying and moderately-elevated parts of the country, even in the north of Scotland.

1186. *Economic uses of timber.*—We have seen specimens of the timber of this tree, and it seems strong and elastic, free from knots, and must be very durable in quality. We cannot, however, speak with full confidence in reference to the quality of the timber grown in this country; but ere long, from the many specimens which have now attained large size with us, we are likely to be able to have the opportunity of proving its strength and general fitness for some of our economic purposes. In the meantime we have no doubt of our finding the home-grown timber of this tree of good quality.

1187. *Soil and situation.*—This species is very accommodating in regard to soil, as we can prove by reference to the many fine specimens in the country found on soils of different descriptions, from that of a light and dry character, to others of a heavy and cold-bottomed nature. The tree seems, however, to like a deep, free, open, moist-bottomed land, and sites not too elevated nor exposed to storms of prevailing winds.

1188. *Propagation and culture.*—This tree is so perfectly hardy that it ripens its seeds in our climate; and from those produced in this country, together with those imported from time to time, we have now a fair supply of plants at as reasonable a rate as can be expected from the supply and demand. No tree is easier of cultivation than the Douglas fir, as the seeds may be sown on the open ground in the same manner as the seeds of the Scots pine and spruce fir, and the young plants may be transplanted into nursery-lines, and treated in the same way as these are usually treated.

1189. Fine specimens of this species are now so plentiful in the country that it is, we think, unnecessary to refer to any in particular. We may state, however, that perhaps those at Dropmore in England, and at Rossie Priory in Scotland, are among the best in the country.

SECTION XLIII.—ABIES MENZIESII, OR MENZIES' SPRUCE FIR.

1190. *Specific character.*—Leaves solitary, thickly scattered on the young shoots, narrow, linear, rigid, sharp-pointed, and incurved (see

Fig. 124.

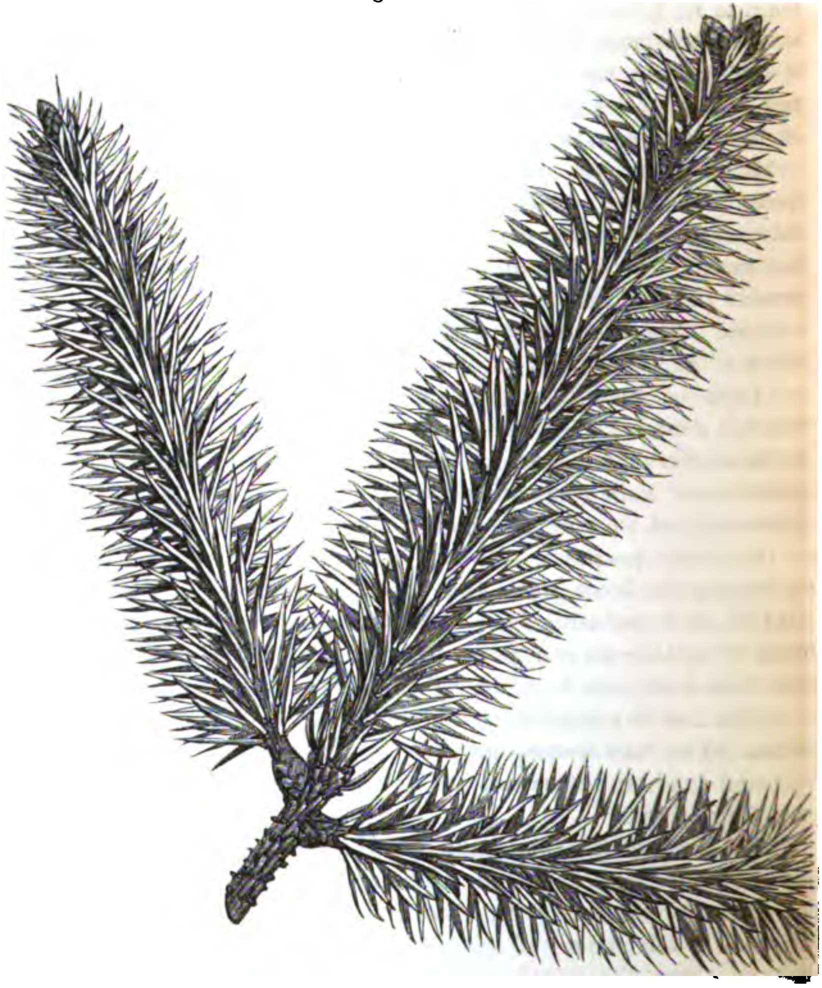


fig. 124); rich vivid green above and quite silvery below, from ¾ to 1 inch long, and soon falling off after the first season, leaving the old branches very naked and warted. Buds ovate-pointed, covered with resin. Cones 2½ to 3 inches long, and 1 to 1½ inch broad, pendulous, cylindrical, blunt-pointed, and with the scales loose and not compact. Bracteas small, and hidden in the scales.

1191. *Geography.*—This fine species of spruce fir was first introduced to notice by Douglas, who sent it home in 1831. It is found in great abundance in Northern California, and on the island of Sitcha, and also in the Shasta country, growing to heights of from 70 to 100 feet.

1192. *Description of tree.*—This forms a highly ornamental tree, being of a pyramidal habit, thickly branched, and of dense foliage, having a beautiful silvery-green aspect. It is thoroughly hardy, and of very rapid growth. It ought to have a place in every pinetum, park, and plantation, as we have no doubt it will become ere long one of our forest-trees.

1193. *Economic uses of timber.*—Douglas describes the wood of this species as being of excellent quality, and we have no doubt it is. We have not seen any specimen of the matured timber; but, judging from the appearance of the wood of some of the larger specimens now growing in the country, which are from 45 to 60 feet high, one is convinced at a glance that the timber is hard, firm, and of a durable description.

1194. *Soil and situation.*—This species, like all the other firs, luxuriates in a loamy cool-bottomed description of land. It succeeds on most lands, however, not too light and dry; but it makes the greatest and most healthy progress on rather loamy lands, which are porous, and at the same time somewhat moist and cool in the bottom.

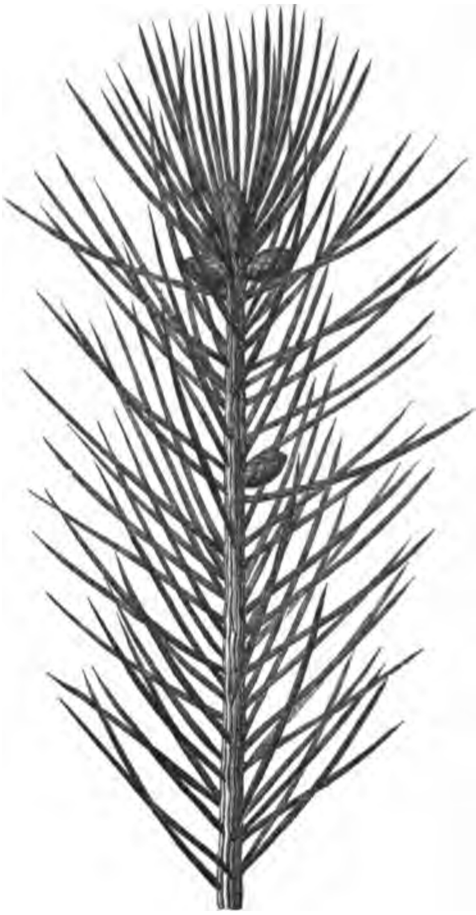
1195. *Propagation and culture.*—The seeds of this species are still scarce, and are to be had only at intervals. Plants, however, in the absence of seeds, can be readily procured from cuttings; and to this mode of propagation cultivators are obliged to resort when seeds are not to be had.

1196. In nearly all good pinetums in Britain there are specimens of this beautiful fir, of heights ranging from 25 to 40 feet.

SECTION XLIV.—ABIES SMITHIANA, OR THE HIMALAYAN SPRUCE FIR.

1197. *Specific character.*—Leaves singly, at nearly equal distances round the shoots, mostly four-sided, somewhat curved, from 1½ inch to 2 inches long, and having very sharp points (see fig. 125). Branches spread out horizontally, those nearest the bottom of the tree somewhat bending downwards; lateral ones very numerous, slender, and drooping. Cones pendulous when matured, from 5 to 6 inches long, and about 2½ inches broad, ovate-oblong, or nearly cylindrical; with very even, brown, obovate, rounded scales, covered with a glaucous bloom when young. The young cones are at first upright, but from their own weight and the slenderness of the branches, and being terminal, soon become pendulous.

Fig. 125.



1198. *Geography.*—This species is found on mountains in the interior of India, at elevations of from 7000 to 12,000 feet, and in its native sites is said to prefer the northern slopes to those of any other aspect. It was introduced into Britain in 1818.

1199. *Description of tree.*—This is a magnificent species of *Abies*, often attaining heights of from 100 to 160 feet, with stems from 4 to 6 feet in diameter near the ground. It is a tree of a very graceful habit: the branches in young trees have an upward tendency, but as they become older they take a horizontal position, from their own weight, till in old specimens they take a drooping form, especially the lower ones; and all the branchlets and small twigs droop in a very graceful manner. It is quite hardy, and ought to be cultivated in every park and pinetum. It has a fine effect in plantations of any kind when planted on the sides of roads and drives running through them, but can be recommended only as an ornamental specimen, as its timber is soft, and said to be of a very perishable nature. To succeed well, this species requires to have a northern aspect.

1200. *Economic uses of timber.*—As already hinted, the timber of this species is comparatively worthless, and therefore it is not to be recommended except as an ornamental tree. For this purpose it is a very desirable species.

1201. *Soil and situation.*—This species also likes a rather moist-bottomed land, but without any tendency to stagnant water in the subsoil. The soil for it, as for all the *Abies* tribe, should be porous and deep, cool and moist-bottomed, and at the same time wholesome and clear of stagnant water. These conditions of soil can always be secured by planting on slopes where there is a natural drainage, or by artificial draining where that is necessary. From an extended experience in regard to this species, we find it likes a somewhat shady situation; indeed, unless it has this it does not succeed so well in our climate as it is capable of doing; but with a judicious degree of shade and shelter combined, such as is to be had when it is planted on the sides of roads in plantations, it thrives well, and soon becomes a highly ornamental tree. It is chiefly the want of attention to these points in the cultivation of the tree that has been the cause of many of the specimens planted in the country not succeeding so well as their owners were led to expect. It will not stand confinement, however, among other trees; it must have perfect freedom all around.

1202. *Propagation and culture.*—The seed of this species is procured from India from time to time, but is still scarce. It may be treated, in sowing it, in the same manner as the seeds of the common Norway spruce fir; and after the young plants have come up they may be transplanted out into nursery-rows in the same way as stated in respect to that tree. In the absence of seeds, plants may be procured by propagation from cuttings; but these do not grow so freely as plants reared from seed.

1203. For good specimens of this tree we have to refer to those at Dropmore and Elvaston Castle, in England, and to those at Hopetoun House and Keir, in Scotland.

SECTION XLV.—ABIES ORIENTALIS, OR THE ORIENTAL SPRUCE FIR.

1204. *Specific character.*—Leaves solitary, very dense, partially 4-sided, covering the branches on all sides, deep green on both sides, narrow, but not sharp-pointed, from $\frac{3}{8}$ to $\frac{4}{8}$ inch long, and rather stout. Branches straight, slender, and well covered with foliage. Cones pendulous when full grown, cylindrical, tapering regularly from near the base to the point, which is small, from $2\frac{1}{2}$ to 3 inches long, and about $\frac{3}{4}$ inch broad at the widest part, which is near the base. Bracteas shorter than the scales, and enclosed.

1205. *Geography.*—This species is found on the coast of the Black

Sea, on the loftiest mountains of Imeretia, in Upper Mingrelia, and the neighbourhood of Teflis, forming whole forests between Guriel and the Adshar Mountains. It was introduced in 1838.

1206. *Description of tree.*—This species is said to attain the size of a large and lofty tree. It is a very hardy tree, seemingly as much so as the common Norway spruce; for we have not, in all our inquiries, learned of any plant having been injured by the frosts of our severest winters since it came among us. It seems rather a slow-growing tree, however; at least in Britain it is so, seldom making more than growths of 12 inches in one year in most places, although in some favourable places it has grown more rapidly. In its native parts it is said to attain heights of from 70 to 80 feet; and we can readily believe this, even although it should grow slowly as compared with other species of *Abies* we have had introduced.

1207. *Economic uses of timber.*—The timber of this species is said to be of excellent quality, tough, elastic, and durable. We cannot judge well of this at the present stage of the tree with us, but we are inclined to think that its timber will be useful.

1208. *Soil and situation.*—The same as those stated in reference to *Abies Menziesii.*

1209. *Propagation and culture.*—The seeds of this species are to be had from seed-merchants on the continent of Europe. The sowing of the seeds, and the treatment of the young plants, are in all respects the same as has been described for the propagation of *Abies excelsa.*

1210. In many pinetums in Britain there are specimens of this fir, of heights ranging from 30 to 35 feet.

SECTION XLVI.—ABIES PATTONIANA, OR PATTON'S CALIFORNIAN SPRUCE FIR.

1211. *Specific character.*—Leaves solitary, placed spirally round the branchlets, not close together, short, with the margin slightly toothed or serrated towards the point, from ½ inch to ¾ inch long, boat-shaped in their section, dark green above, curved, not silvery below. Buds small, conico-ovoid. Branchlets pubescent. Cone produced at the points of the branches, from 2 to 2½ inches long, cylindrically oblong, tapering at both ends, but most so at the top, nearly ¾ inch broad, and pendulous. Branches pendulous. Bark rough, and of a grey colour.

1212. *Geography.*—This species was found by Jeffrey on the Baker range of mountains, and on the Cascade Mountains, in California, at elevations of more than 5000 feet above the level of the sea. Mr Lobb afterwards found it in abundance on the highest peaks of the Sierra Nevada, near the head-waters of the north tributary of Feather River, and more to the south, towards Lake Bingler. It was introduced in 1851.

1213. *Description of tree.*—This species is said to grow to an immense size in the Oregon country, where not unfrequently trees are seen towering to 250 feet high, with stems above 10 feet in diameter. Its branches spread out horizontally from the main stem, but become drooping towards the extremities, and with the branchlets thickly set round with solitary leaves, which are of a grass-green colour above, and pale green below. It is said that in its habit of growth and general appearance it much resembles the Deodar, but is more thickly branched, and densely clothed with foliage, and forming a handsomer tree. It is found quite hardy, and is worthy of a place in every pinetum.

1214. *Economic uses of timber.*—From the account that Mr Jeffrey gives of the timber of this tree, we are of opinion that it is likely to prove useful as an addition to our timber-producing ones, but we require time to prove this. It is said, however, that the timber is excellent; that it splits freely, and is quite straight in the grain.

1215. *Soil and situation.*—Same as those stated for *Abies Menziesii.*

1216. *Propagation and culture.*—The seeds of this species are still very scarce, and in consequence of this a large proportion of the plants that are to be had of it are propagated from cuttings.

1217. We have not had returns to our inquiries as to the sizes this species has attained in different parts of the country; but we may here state generally, that specimens of it are plentiful in most pinetums, of sizes varying from 10 to 15 feet in height.

SECTION XLVII.—ABIES ALCOQUIANA, OR ALCOCK'S SPRUCE FIR.

1218. *Specific character.*—Leaves solitary, six lines long, and half a line broad, curved, rigid, 4-sided, sharp-pointed, and crowded on all sides of the shoots. They are deep green above, somewhat concave, and streaked with glaucous bands below, and on twisted footstalks, placed on diamond-shaped cushions along the shoots. Cones solitary or subaggregate, oblong-cylindrical, obtuse at the ends, 2 inches long and 4 inches in circumference.

1219. *Geography.*—This species of fir is found on the sacred mountain Fusi-Yama, in the province of Surunja, on the Island of Nippon in Japan, at an elevation of from 6000 to 7000 feet, where it forms a noble tree, with very small leaves, which are glaucous on the under side.

It was first introduced by Messrs Veitch & Sons in 1861, and named in compliment to Sir Rutherford Alcock, the British minister at the court of Yeddo, in Japan.

1220. *Description of tree.* — In its native sites this is a large tree, attaining heights from 90 to 100 feet. As this species is but of recent introduction, we have no large specimens in Britain to show the true character of the tree; but we may state, from what we know and have seen of it, that it is in all respects quite hardy in our climate, forming a beautiful silvery foliaged tree, of very graceful habit, and we are confident in recommending it as a specimen in all respects worthy of taking a place in our pinetums.

1221. *Economic uses of timber.*—On this point we have as yet no reliable information.

1222. *Soil and situation.*—This species is by no means particular as to soil and site, provided the former is not wet, and the latter not too much exposed to prevailing winds. We have seen fair specimens of it on a great variety of soils, and all seemed healthy.

1223. *Propagation and culture.*—Same as those stated for *A. Pattoniana.*

SECTION XLVIII.—ABIES RUBRA, OR THE RED SPRUCE FIR.

1224. *Specific character.*—Leaves solitary, very slender, awl-shaped, rigid, sharp-pointed, thickly and regularly scattered all round the branches, somewhat 4-sided, ½ inch long, and of a glaucous pale green colour. Branches horizontal and slender. Cones oblong, egg-shaped, tapering regularly to both ends, pendulous, about 1 inch long and ½ inch broad, and of a reddish-brown colour.

1225. *Geography.*—This species is found plentifully in Nova Scotia, Newfoundland, and the northern parts of North America, and is in all respects hardy, even in the north of Scotland.

1226. *Description of tree.*—This forms a tall and handsome tree, varying in height according to soil and situation. In the northern parts of Canada we have seen this species, on good, deep, loamy soil, attaining heights over 80 feet, and here forming a beautiful upright pyramidal tree, clothed with a mass of branches and foliage from the ground to the top. We recommend this beautiful species as an ornamental one among other trees of a spreading habit, whether in plantations, parks, or lawns, as in all cases its tall and regularly tapering form contrasts well with trees of spreading habits, such as pines and hardwoods generally.

1227. *Economic uses of timber.*—The timber of this species is hard and durable, and is much used in Newfoundland for many purposes.

1228. *Soil and situation.*—Although this tree is a native of the cold regions of North America, still it will not succeed well in Britain unless it is planted on a good, deep, and rather dry soil, with a sheltered site.

1229. *Propagation and culture.*—The red spruce fir is easily raised from seeds, sown in the open ground in the same way as the seeds of the common spruce fir. The seeds are small, and should not be covered with more than half an inch of very fine earth. As the plants are very small the first year, they should be allowed to stand two years in the seed-beds before they are planted out into nursery rows.

SECTION XLIX.—THE SILVER FIR (PICEA)—LINNÆAN SYSTEM, MONŒCIA MONADELPHIA.

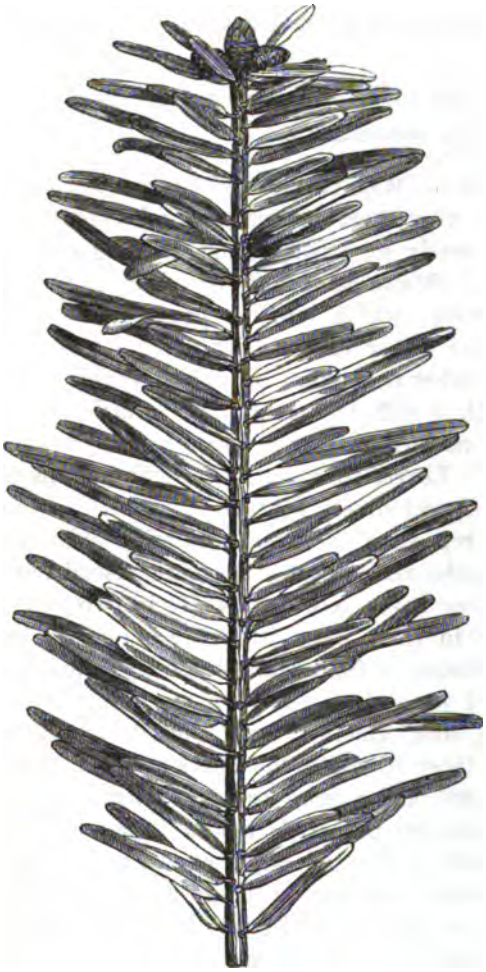
1230. *Character of the genus.*—Male catkins axillary or terminal; the female ones solitary, on very short branchlets, and cylindrical. Cones erect, cylindrical, or nearly so, axillary, and growing on the upper side of the branches. Scales deciduous, or falling off when ripe from the axil of the cone, which remains persistent on the branches. Bracteas dorsal, and either enclosed by or projecting beyond the scales. Seeds somewhat triangular, full of turpentine, two under each scale, covered with a soft tegument, and furnished with an ample, persistent, membranaceous wing, more or less wedge-shaped. Seed-leaves in fives. Leaves solitary, flat, pectinated more or less in two rows, persistent, and silvery below.

1231. The silver firs are remarkable for the regularity and symmetry of their pyramidal heads, and are readily distinguished from the genus *Abies* by their leaves being more decidedly in two rows; by their cones being upright in their position on the branches; by these having the scales deciduous, or falling off when ripe; and by the seeds being irregular and somewhat triangular in form. They are natives of Europe, Asia, and America, but generally found in regions more temperate than those in which the *Abies* abounds. All of them require a good deep soil and a more or less sheltered situation in order to develop themselves properly; but in most ordinary soils they will do tolerably well if not too much exposed, or on too high an elevation. The greater number of them are sufficiently hardy for the average climate of Britain, and grow freely after they have established themselves in the soil. Some of them are only recently introduced into Britain, however, and are still comparatively rare; and therefore of these our experience is as yet but limited. For ornamental planting of every sort they are particularly well adapted; and all the kinds about to be described may be considered hardy and suitable for this purpose.

SECTION L.—PICEA PECTINATA, OR COMMON SILVER FIR.

1232. *Specific character.*—Leaves solitary, flat, obtuse, two-rowed, and with their points turned up; from ⅝ to 1½ inch long, stiff, and of a shining dark-green above, with two lines of a silvery white on each side of the midrib beneath (see fig. 126). Cones from 6 to 8 inches long, and from 1½ to 2 inches broad, cylindrical, erect, and axillary, green when young, afterwards reddish, and when ripe of a brown colour.

Fig. 126.



1233. *Geography.*—The *P. pectinata* is indigenous to the mountains of Central Europe, and is found also in the west and north of Asia. It is found in France, on the Pyrenees, the Alps, in Italy, Spain, Greece, and in the south of Germany and Russia. On the Carpathian Mountains it is said to be found growing at an elevation of more than 3000 feet above the sea-level, and on the Alps to the height of nearly 4000 feet. It was introduced into Britain in 1603.

1234. *Description of tree.*—This is a noble-looking and very useful tree, and by far too little cultivated in our home plantations. It attains large dimensions in favourable situations in Britain, being often found rising to heights considerably above 100 feet, with stems from 3 to 5 feet in diameter. When young, this species is one of the most tender of our timber-trees, being often injured by late spring frosts, thereby retarding its growth considerably. After the roots of the plants become properly established in their sites, however, and when the plants have attained some 5 or 6 feet in height, the frost has no effect on the young growths, and the trees begin to grow rapidly, soon making up for their slow growth when young, and generally surpassing even the spruce fir when they have attained some 15 or 20 years of age. Although the tree is somewhat tender while in its young stages, it is, notwithstanding, hardy enough for our climate, as the many fine specimens now growing in all parts of the country give proof.

1235. *Economic uses of timber.*—When the timber of this tree has arrived at maturity it is of good quality, and in Britain is generally reckoned equal to that of the Norway spruce fir, and is used for the same purposes. The quality of the timber is affected much by whether the tree is grown singly in a park or in masses in a plantation. When the tree is grown singly, with all its branches developed, the timber is open and soft, as compared with that of trees grown in a mass, and from this having but few branches; in the latter case the timber is much closer-grained, of finer quality, and sells at a higher price than in the other.

1236. *Soil and situation.*—This species thrives best upon a good deep loam, not too light nor too dry. However, from having seen excellent crops of this tree on rather stiff clayey soils, as well as on soils of an opposite nature, we are prepared to say that it is by no means particular as regards the quality of the soil, provided that is deep and the situation sheltered. It does not succeed well on an exposed site: all the best trees in the country are to be found on sheltered sites, while those on exposed ones are found small, and not rising to any height. This species is well adapted for planting on land from which a crop of timber has been taken, and may be planted on such sites with success shortly after the crop of old timber has been removed.

1237. *Propagation and culture.*—This species is propagated from the seeds in the same manner as has been already recommended for the spruce fir. The cones are generally ripe about the 1st of November, and the seeds are very easily separated from the cones by the heat of the sun in dry airy days. It should be sown about the first week of April, upon beds, rather thinly, as the young plants, when they come up, are somewhat spreading in their habit. The plants should remain two years in the seed-beds, when they may be planted out into nursery-rows; rather thinly also—as they are, when young, of a bushy nature, and do not agree with confinement. They are of slow growth in their young state, and will require three years in the rows before transplanting into the forest ground. It has been already stated that the plants are tender in their young state. This is so much the case, that generally it is found necessary to protect them in the beds when they have first appeared above ground in the months of May and June, as a very slight frost injures the plants in their then soft and tender state.

1238. Large trees of this species are common in most parts of the country, many of them of heights from 90 to 110 feet, with diameters of stem from 3 to 4½ feet.

SECTION LI.—PICEA BALSAMEA, OR BALM OF GILEAD SILVER FIR.

1239. *Specific character.*—Leaves solitary, entire, or emarginated at the end, irregularly two-rowed, and mostly on the upper part of the branches, or scattered round the leading shoots, spreading, flat, silvery beneath and bright green above, ¾ inch long, and thickly set on the branches. Cones cylindrical, tapering towards the point, erect on the upper part of the branches, or nearly so, 3 to 4 inches long, and about 1¼ inch broad, of a dull violet colour, and sessile. The bark of the tree is thickly interspersed with small vesicles containing a clear limpid resin. Points of the cones generally tipped with resin, and also the buds.

1240. *Geography.*—This tree is indigenous to the northern states of America, to Canada, and Nova Scotia. In these parts we have found the tree growing on cold wet-bottomed lands, and frequently on the edges of swamps. In all cases it forms only a low tree, seldom exceeding 40 feet in height. It was introduced into Britain in 1696.

1241. *Description of tree.*—This is a well-formed pyramidal tree, in its general appearance resembling the common European silver fir; but very seldom, even in its native soil and climate, found above 40 feet high, with a stem of from 12 to 14 inches diameter near the ground. It grows rapidly in its young stages, but in Britain it does not live to a great age, and seldom is found of more than thirty years' standing, as it then seems to become mature with us, and afterwards soon dies off. It is a useful small tree, however, as it grows up at first much more rapidly than the common silver fir, and produces shelter to other more valuable trees at a comparatively early stage. From the premature character of the species, it has become rather scarce in this country, although it is perfectly hardy and adapted to our climate. Planters seem to have lost taste for it from the fact that it generally becomes matured and dies off when other kinds of trees of the same age are in their most vigorous state of growth. It cannot, therefore, be recommended but as a hardy specimen of the *Picea* family, suited to make variety in a pinetum for a few years, and to give its shelter to more tender coniferæ till they attain strength and hardihood to stand without it.

1242. *Economic uses of timber.*—In consequence of the smallness of this tree, its timber is not applicable to many purposes, even in America. It is not plentiful in Britain, still there are some fair specimens here and there.

1243. *Soil and situation.*—This species will not prosper except on a deep, rich, moist soil. On light and dry soils it soon perishes; on such we have seen it mature and die off when only some twenty years of age, although it had grown fast on it for the first ten or twelve years of that period. In order to have this species to live for the greatest length of time its nature is capable of, it should be planted in a soil such as the willow thrives best in.

1244. *Propagation and culture.*—This species produces cones, and sometimes ripens its seeds in this country, and it may be readily propagated from either home-grown or imported seed by the mode of treatment we have already recommended for the propagation of *P. pectinata.* The young plants of this species grow much more rapidly than those of *P. pectinata,* and therefore they do not require to stand so long in the nursery-rows before they are fit to be put out on their permanent sites.

1245. On many places in the country specimens of this Picea are to be found, from 25 to 35 feet high.

SECTION LII.—PICEA AMABILIS, OR THE LOVELY SILVER FIR.

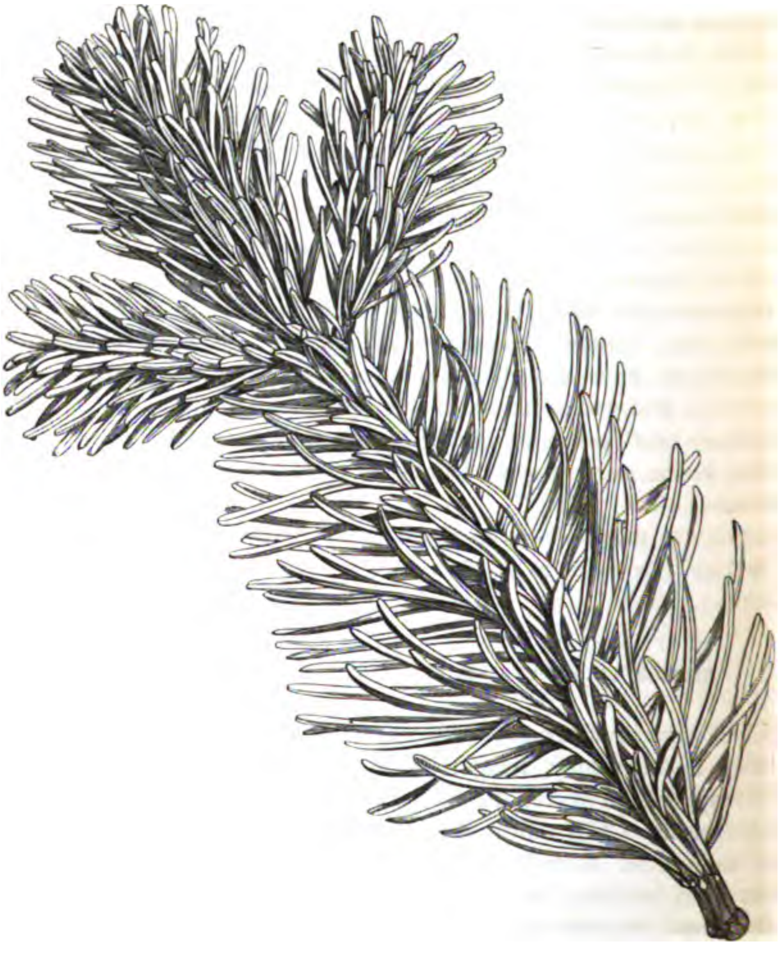
1246. *Specific character.*—Leaves solitary, linear, flat, entire, blunt-pointed, 1½ inch long, irregularly and densely two-rowed, incurved on the upper side of the branches, bright green above and glaucous below (see fig. 127). Branches irregular on the main stem; lateral ones numerous, tolerably flat, and densely covered with leaves. Cones erect, solitary, large, ovate-cylindrical, 6 inches long and 2½ inches broad, slightly tapering to both ends, and woolly when young.

1247. *Geography.*—This species is from Northern California, where in its native forests it is found growing 200 feet high. Mr Jeffrey found it growing on the slopes of the mountains at an elevation of 4000 feet, with the leaves very small, dark green above and silvery beneath, with horizontal branches, short and bushy, growing 250 feet high in a gravelly soil, and 5 feet diameter. It was introduced in 1831.

1248. *Description of tree.*—This is a very handsome and hardy species of Picea, forming a densely-clothed tree, and taking a beautiful pyramidal habit of growth as it attains age and size.

1249. *Economic uses of timber.*—As we have no reliable accounts as to the quality of the timber of this species, we cannot speak on the subject of it.

Fig. 127.



1250. *Soil and situation.*—So far as we have had experience in the cultivation of this species, it seems to grow well in any common loam, rather heavy than light, and at the same time deep and open in the subsoil; and its place is certainly in a low-lying and rather sheltered situation. It thrives well, however, even on moderately-exposed parts, but on such it does not grow so fast as on a rather low-lying and sheltered site.

1251. *Propagation and culture.*—The seeds of this species are still very scarce, and therefore the most of the plants we have in the country have been propagated from grafts. Young plants are very high-priced in consequence of the want of seeds. We have ourselves had no experience in the rearing of this species from seed, as we have not been able to get it anywhere. We are therefore compelled to rear our stock of young plants of this species by grafting it on stocks of more plentiful kinds.

1252. In most good collections of the newer coniferæ fair specimens of this species are to be found, of heights varying from 10 to 15 feet.

SECTION LIII.—PICEA BRACTEATA, OR THE LEAFY-BRACTED SILVER FIR.

1253. *Specific character.*—Leaves solitary, 2-rowed, linear, tapering to both ends, alternate, flat on the upper side, entire, and sharp-pointed, from 2 to 2½ inches long, and rather more than one-tenth of an inch wide, bright green above, ribbed with two silvery white lines below, crowded and scattered at the insertion on the branches, but 2-rowed and extended above. Branches in whorls, spreading, slender; lower ones drooping, lesser ones bent downwards. Buds composed of large, loose, elliptic, pale yellow scales, destitute of resin, axillary, and scattered along the branches, but mostly towards the points. Cones ovate, erect, on very short footstalks, 4 inches long and 2 inches wide, in great clusters on the upper side of the top adult branches. Scales kidney-shaped, concave, and rounded on the upper margin, and stipulate at the back. Bracteas wedge-shaped, 3-lobed, the middle one 2 inches long, recurved, particularly those towards the base, which are the longest, while those towards the summit are nearly straight, much shorter, and but little changed in appearance or colour from the ordinary leaves. The lateral lobes are very short, and extend very little beyond the end of the scales.

1254. *Geography.*—This species was first discovered by Dr Coulter on the sea-range of Santa Lucia in Upper California, at an elevation of from 2500 to 3000 feet above the sea-level. Douglas afterwards met with it at an elevation of 6000 feet on the Californian mountains, in lat. 36° N. Introduced into Britain in 1857.

1255. *Description of tree.*—This species is said to attain heights of from 120 to 150 feet, with stems straight as an arrow, but rather slender, seldom exceeding from 2 to 3 feet diameter. We have as yet no large specimens of the tree in this country to enable us to judge of its character; but judging from the plants we have, we should say that it is likely to form a handsome tree with us, and is well worthy of a place in our parks and pinetums. It may be characterised as *tolerably* hardy. It is predisposed to start into growth early in the season, and in consequence of this it is liable to get injured by late spring frosts. On this account it should always be planted on a northern aspect, and never on eastern or southern ones.

1256. *Economic uses of timber.*—As yet we have no particular accounts as to the qualities of the timber of this species. It is said to be very resinous, and this may be taken as a good index of its durability.

1257. *Soil and situation.*—It is said that the natural soil for this species is that on a limestone formation. If so, the tree must be most suited for the chalk and limestone districts of this country. It seems to grow well, however, on the common loams of the country, but does not succeed on very light nor on heavy soils. In making these latter remarks, we speak from our own observations in respect to the species as we have found plants of it in various parts of the country. As to situation, from its disposition to start early into growth in spring, it should be planted on a northern or western aspect, as by doing so it will not start so early into growth as it would do on an opposite aspect, and will on that account be less likely to be injured by late frosts in spring.

1258. *Propagation and culture.*—The seeds of this tree are still very scarce, and difficult to be obtained. It requires to be sown in a cold frame with us; and the young plants need protection for the first two winters after they have come up. As they attain size and firmness in the texture of their wood, they become quite hardy, however; and after they have become pretty stout, the only thing to guard against is the liability of the young growths to be injured by frosts in the first of summer when they start to grow. In this respect the species under notice resembles our common silver fir, both being liable to be injured by frosts when young, but gradually becoming hardy as they attain size and firmness in the texture of their wood.

1259. Specimens of this very pretty Picea are now plentiful, and in most good pinetums they are found of heights of from 15 to 20 feet.

SECTION LIV.—PICEA GRANDIS, OR THE GREAT CALIFORNIAN SILVER FIR.

1260. *Specific character.*—Leaves linear, flat, channeled above, emarginate, or with a small notch at the point, and all irregularly arranged horizontally in double rows on each side of the branchlets, in a more or less pectinate manner, on short twisted footstalks; those forming the upper tiers on each side of the shoots are much the shortest, and little more than ¾ of an inch in length, while the majority of those comprising the under series are of various lengths, and nearly double that of the upper ones, but not broader, and all of a deep glossy green above, and with two silvery-white bands below, between the mid-rib and thickened margins, both of which are of a bright-green colour. Branches mostly in horizontal whorls, flat and spreading; branchlets glossy, smooth, rather short, compact, and placed laterally in two horizontal rows, and, when young, with quite a varnished appearance. Cones erect, cylindrical, and from 3½ to 4½ inches long and 1½ inch broad. Scales broad transversely, crescent-shaped, rounded on the exposed part, incurved at the edges, closely placed, tolerably equal in size, downy externally, deciduous when fully matured, and with the small fringed dorsal bracteas entirely hidden by the overlapping scales.

1261. *Geography.*—This truly grand species of Picea was first discovered by Douglas in Northern California, but more recently Mr Bridges and others found it in British Columbia and Vancouver Island. Douglas first sent its seeds to Britain in 1831.

1262. *Description of tree.*—In its native habitats this tree grows to a large size, from 150 to 200 feet in height, with a habit very much resembling the common silver fir when the trees are full grown, but differing in the young shoots having a polished and glossy appearance. The very deep glossy green of the foliage of this species gives it a cheerful aspect, and, besides, the denseness of its foliage gives the tree a fine clothed appearance, making it in all respects as handsome and as ornamental a species of Picea as we have. The tree is quite hardy, although, like our common silver fir, it is liable to have its young shoots injured by late frosts in the younger stages of its growth, from its tendency to start early into growth, especially if it is planted on an early or southern exposure.

1263. *Economic uses of timber.*—We have no reliable information to give on this point.

1264. *Soil and situation.*—This species seems to grow best on a cool and somewhat moist-bottomed land, such as generally prevails in alluvial and flat parts of the country. It does well, however, on dry lands, even at considerable elevations, as is proved from the success of many fine specimens now growing luxuriantly in many parts of the country. It is as hardy as our common silver fir, and is deservedly a general favourite with all arboriculturists. We have to recommend that this species should be extensively planted in the parks of our landed proprietors, as there are few trees of a more ornamental character, and as it cannot fail to succeed well on most parks when planted in proper situations among existing old trees, which would shelter it from prevailing storms till it got of some size to resist them itself.

1265. *Propagation and culture.*—The seed of this species is still scarce, and only to be had in small quantities from time to time. It is so valuable that most cultivators sow it in a cold frame, in order to prevent risk from frost to the young plants, which are generally protected for the first year or two, and gradually exposed as they become stronger. As already stated, the tree is as hardy as our common silver fir, and were the seeds of the one as plentiful as those of the other, no sowing in cold frames would be necessary for the one under notice. It is the scarcity of the seed of this tree that makes us so careful of the plants we rear from it. Many plants are, however, still reared by grafting and layering.

1266. Specimens of this Picea, of heights of from 20 to 30 feet, are now plentiful in the country.

SECTION LV.—PICEA CEPHALONICA, OR THE MOUNT ENOS FIR.

1267. *Specific character.*—Leaves solitary, flat, dagger-shaped, and standing at nearly right angles on every side of the branches, but chiefly on the upper side, of a dark shining green above, and with two silvery lines beneath, tapering from the base to the point, which terminates in a sharp point; footstalks very short, dilated at the base, and twisted. Buds prominent, stiff, pointed, and covered with a glossy resin. Branches very numerous, in regular tiers on the main stem, but branching in all directions in the lateral ones. Cones erect, straight, cylindrical, axillary, tapering at both ends, 5 or 6 inches long and 1½ inch broad. Scales rounded on the upper part, broad and entire, wedge-shaped below. Bracteas projecting beyond the scales, linear-oblong, with the lower end much attenuated, and tapering gradually into a stiff, unequally-toothed, and reflexed sharp point at the top.

1268. *Geography.*—This beautiful species of Picea is found on the highest mountain in Cephalonia, called Mount Enos, or the Black Mountain, at an elevation of some 4000 or 5000 feet, and was introduced into Britain by General Napier when Governor of Cephalonia; but it has since been found on the different mountains in Greece, particularly on the Sacred Apollo and Mount Parnassus, also on the lofty and rugged Mount Œta. Introduced in 1824.

1269. *Description of tree.*—It is said that this species of silver fir in its native mountains attains great bulk of timber, but does not rise to very great heights of stem. It seems to grow with a spreading head to the height of some 60 feet, often with stems 10 feet in circumference. This forms a very beautiful tree when standing alone on a park, its numerous and regular tiers of branches standing very close together giving it a peculiar aspect. In its younger stages the tree is very branchy, looking generally more like a large bush than a young tree; but after it gets fairly established in its site, it grows more rapidly to height, and ere long assumes a fine pyramidal tree-form. It is quite hardy on dry situations at a moderate elevation, but does not prosper well on high or exposed sites. It seems to thrive best on sites not far from the sea, and least so on high-lying inland sites. In the latter situations it gets injured by frost.

1270. *Economic uses of timber.*—The timber of this species is said to be hard and durable, and on examining the nature of the young wood of it, it seems close-grained, and likely to produce good timber when matured.

1271. *Soil and situation.*—From examinations of the land on which we have found this tree growing, we should say that it prefers a good, dry, light loam to any other description of soil. On heavy and cold-bottomed lands, where many of the other silver firs grow luxuriantly, this one does not prosper, but remains a stunted bush, generally speaking; but on light and dry loams not much elevated we have always found the tree prosper well, generally making growths of from 12 to 14 inches a-year, and sometimes even more in the leading shoots. This is a tree which deserves a place in every park and pinetum, as its dagger-shaped foliage, standing at nearly right angles upon the branches, gives it a peculiar effect among other trees, of whatever kinds.

1272. *Propagation and culture.*—Although a few packages of the seed of this tree come to hand now and then, still it is very scarce and difficult to be had, and it very often happens that the seeds imported are bad, and few plants can be had from them. When received, it is best to sow it as has been recommended for the propagation of the immediately foregoing species. We may mention here, however, that the species under notice is very readily propagated by cuttings, and that the greater part of the plants sold are produced in this way. They may be also propagated by layering.

1273. There are few pinetums in this country that have not fair specimens of this Picea, some of them of heights ranging from 40 to about 50 feet.

SECTION LVI.—PICEA LOWIANA, OR LOW'S CALIFORNIAN SILVER FIR.

1274. *Specific character.* — Leaves long, linear, flat, and quite straight, channeled above, more or less twisted at the base, rather distant, and strictly arranged in two horizontal rows along the shoots, and from 1½ to 2½ inches long, and $\frac{1}{10}$ of an inch broad, blunt-pointed, or with a slight notch in the centre, particularly those on the adult trees, and all of a dull glaucous green above, but much paler, and with two faint glaucous bands below, between the elevated mid-rib and thickened margins. Branches in distant whorls, horizontally placed, and rather slender; branchlets more or less opposite, quite smooth, slender, laterally placed in two horizontal rows, and of a pale yellowish colour. Cones from 3½ to 5 inches long, and 1½ inch broad, erect, cylindrical, obtuse at the point, rounded at the base, of a pale-brown colour, and emitting numerous transparent resinous tears externally, and very similar in shape and general appearance to those of *Picea grandis*, but somewhat larger. Scales broad, more or less crescent-shaped, rounded on the outer side, incurved round the margins, woolly on the exposed parts, tolerably equal in size, and deciduous when fully matured. Bracteas very minute, dorsally placed at the base of the scales, broader than long, somewhat rounded, wedge-shaped on the upper part, toothed or fringed round the edges, and with a prolonged sharp point in the centre.

1275. *Geography.*—This species is found in British Columbia and Northern California frequently upwards of 250 feet high, with stems from 4 to 6 feet in diameter, and for the most part in valleys and on the alluvial banks of rivers. Introduced in 1860.

1276. *Description of tree.*—This species is very frequently found in places under the name of *P. lasiocarpa*, and we think it well to note this here to avoid any misunderstanding that might arise from the difference of the names. Some consider the *P. lasiocarpa* as a distinct species from *P. Lowiana*, but the difference seems too unimportant to be specific. This species also forms a grand and beautiful tree, and is well deserving of a place in every collection of coniferæ, and in every park where variety of form and foliage is aimed at in the most perfect manner that can be attained. There is no stiffness in the habit of this species, as the branches are developed in distinct whorls, and horizontally placed, and their rather slender forms give the whole plant a natural and graceful outline, which is much improved by the comparative light green of the—for a Picea—long leaves. This is also a very hardy species, which is a great recommendation to it. It does not start into growth early like some of the Picea family, and from this its young shoots are never injured by late frosts, but are preserved healthy and uninjured all the season round; therefore we need only remark further under this head, that the tree is one that ought especially to be cultivated, as its hardihood for our climate seems already undoubted and established, although it has not yet been many years among us.

1277. *Economic uses of timber.*—As yet there are no reliable accounts as to the quality of the timber of this species.

1278. *Soil and situation.*—For this species these may be the same as has been stated in reference to *P. grandis.*

1279. *Propagation and culture.*—The seeds of this species are as scarce as those of *P. grandis*, and are seldom to be had. When it does come to hand it is sown in a cold frame to insure its success, and if possible to prevent the failure of even one plant. Plants are generally propagated from grafts and layers, however.

1280. Of this species specimens are plentiful in many parts of the country, of heights ranging from 20 to nearly 30 feet.

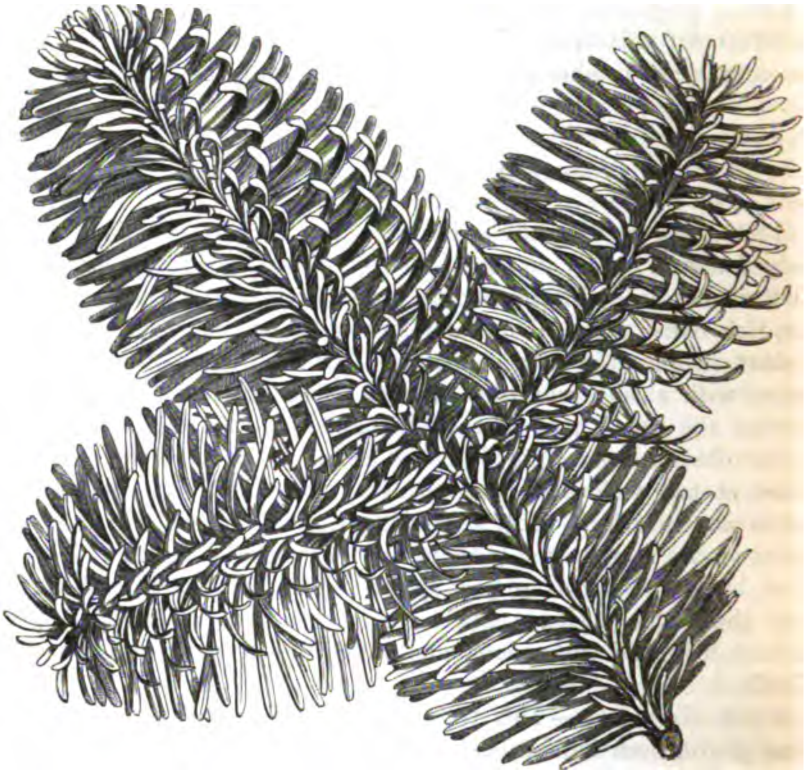
SECTION LVII.—PICEA NOBILIS, OR THE NOBLE SILVER FIR.

1281. *Specific character.*—Leaves solitary, rigid, crowded, irregularly 2-rowed, mostly on the upper side of the branches, from ¾ inch to 2 inches long, linear, falcate, compressed, and turned upwards, flat, rich bluish green above, and silvery below, and when viewed at a short distance the foliage appears a beautiful mass of rich silvery green, with shades and tints of violet (see fig. 128). Cones solitary on the upper part of the top branches, cylindrical, thick, and rather obtuse, from 5 to 8 inches long, and from 2 to 3 inches broad, at first yellowish green, changing to yellowish purple as they arrive at maturity. Scales triangular, with the edges incurved, entire on the margin, and without the bract, 1¼ inch long, and the same broad. Bracteas projecting, imbricated backwards, and longer than the scales, jagged round the edges on the exposed part, ⅝ of an inch long, and with a long and rather broad point or tail in the middle.

1282. *Geography.*—This tree forms vast forests upon the mountains of Northern California. It is found growing on the north-west coast of North America, along the banks of the Columbia River. Mr Jeffrey found it on the Shasta Mountains at an elevation of from 6000 to 8000 feet above the sea-level. It was introduced into Britain by Douglas in 1831.

1283. *Description of tree.*—This is perhaps one of the most ornamental of the Picea tribe. It grows to heights varying from 150 to 200 feet, with stems from 3 to 4½ feet in diameter, forming truly grand specimens, both in respect to bulk of timber and ornamental appearance. The branches grow out nearly at right angles to the stem, forming as it were horizontal tiers, densely clothed with beautiful, short, curved leaves, which, on the younger branches, are of a delicate silvery green, and on the older ones of a much darker hue. The bark of the stem of the tree is of a cinnamon colour, but on the younger branches it is of a yellowish green, while on the older ones it is of a purple hue. This is a thoroughly hardy tree, of tolerably rapid growth in this country, and seems to suit our climate well, always, as it were, keeping up a sound constitution, and never affected by our coldest winters.

Fig. 128.



1284. *Economic uses of timber.*—The timber of this species is of a soft description, and white in colour, so that as a timber-tree it must rank only in the second class.

1285. *Soil and situation.*—This tree seems by no means particular as to soil and situation, for we have good and healthy specimens of it growing well in most kinds of soils, and on a great variety of situations. Hitherto it has, of course, like all other of our rarer trees, been planted in special spots, so that we have not yet had a wide range of experience as to how far it may be suited to grow on very dry and exposed hillsides, or on cold-bottomed hollows, such as the common silver fir thrives well on. Still, we are led to think, from our observations as to the constitution of the species, that it is adapted to grow better on cool-bottomed lands than on those of a dry nature.

1286. *Propagation and culture.*—This species is hardy, and easily raised from seeds sown in the usual way without any special protection whatever. Seeds of this tree ripen in Britain, and plants have been raised from them; but in all cases where seeds can be had gathered from trees grown in its native forests in California, they are to be preferred, as plants raised from seeds taken from trees grown in Britain are generally found of a comparatively weak constitution, and frequently become diseased at an early stage of their growth. It is now a well-understood fact that plants—not only of this species, but of others of the cone-bearing kinds—raised from home-grown seeds, are not so strong and healthy as plants grown from seeds brought from their native country; and it has been observed that a very large proportion of the seedlings from home-grown seeds become diseased at an early stage, the leaves first decaying at the points, and gradually becoming wholly dead. As this is a subject of vast importance to arboriculture, we intend to devote a section specially to its consideration, which the reader will find in its own place in this work.

1287. Large specimens of this noble tree are now plentiful in the older pinetums of Britain; many of them of heights varying from 40 to nearly 60 feet.

SECTION LVIII.—PICEA NORDMANNIANA, OR NORDMANN'S SILVER FIR.

1288. *Specific character.*—Leaves solitary, somewhat 2-rowed, curved upwards, linear, from ¾ inch to 1 inch long, with the point emarginate, pale yellowish green above, channeled below, with a silver glaucous line on each side of the midrib, equal in breadth to the keel, and thickened margins, more or less twisted at the base, and flat. Branches dense, and regularly disposed, the lower ones horizontal, the upper ones rising at a more acute angle; young shoots quite smooth and glossy. Cones on very short footstalks, erect on the upper side of the branches, from 4½ to 6 inches long, 2½ inches diameter, and egg-shaped, a little blunted at the ends. Scales closely adpressed, cup-shaped, very obtuse. Bracteas adhering to the narrow base of the scales, but afterwards free and extending beyond the scales, getting wider by degrees from the base outwards, rarely ovate, often cordate, reflexed at the apex, and incumbent on the lower scale, with the point a line and a half long.

1289. *Geography.*—This species is found very common on the mountains of the Crimea, and the Alpine regions to the east of the

Black Sea. Professor Nordmann of Odessa discovered it first on the summit of the Adshar Mountains, towards the sources of the Kur, at an elevation of 6000 feet. It was introduced into Britain in 1845.

1290. *Description of tree.*—This is decidedly the hardiest species of silver fir that has yet been introduced into this country, being, in our opinion, more hardy than our common silver fir, as we have never seen its young shoots in any way injured by late frosts, while those of the common silver fir are generally very much so. This of course arises from the fact that the *P. pectinata* starts into growth early in the season, while the *P. Nordmanniana* does not begin to grow till the season is well advanced and the frosts have passed. This is truly a noble species of Picea, and is worthy of general cultivation in all plantations, not only for ornament, but for the sake of its timber as well, as that is known to be fully equal to the timber of the *P. pectinata*, or common silver fir. Its habit of growth while young is broad and bushy. As it becomes well established in the ground, however, it pushes rapidly upwards, ere long becoming a well-balanced and majestic tree, densely clothed with beautiful light-green foliage, altogether forming a highly ornamental object.

1291. *Economic uses of timber.*—The timber of this species is said to be good, and harder than that of the celebrated Oriental spruce fir. It seems, however, that this species does not attain such a large bulk of timber as the common silver fir does, its general height being stated as under 100 feet, and seldom found to exceed that height.

1292. *Soil and situation.*—So far as we have had experience in the cultivation of this Picea, we are led to state that it does well in almost all descriptions of land not absolutely wet nor excessively light and dry. The tree, so to speak, seems to be of an iron constitution, capable of growing healthily and profitably in all soils and situations where pines and firs generally will grow.

1293. *Propagation and culture.*—This species requires no particular mode of treatment in its propagation. The seeds can now be had plentifully as compared with those of many other kinds of Picea, and are procured from seed-merchants on the continent of Europe. When received they may be sown on any moderately good piece of land, in the same way as recommended for the common silver fir, and the young plants may be dealt with in the same way as recommended for those of that species.

1294. Specimens of this Picea are plentiful on many parts of the country, of heights from 25 to 40 feet.

SECTION LIX.—PICEA PINDROW, OR THE UPRIGHT INDIAN SILVER FIR.

1295. *Specific character.*—Leaves solitary, flat, and at first all round the shoots, but finally disposed into two rows on the branchlets horizontally, with the upper surface of the deepest green, almost black when fully matured, and the under one having two faint, white, silvery lines, from 1½ to 2½ inches long, and rather more than one line broad, with acutely two-toothed ends. Branches in whorls, horizontal, and spreading; branchlets opposite in two rows. Cones erect, solitary, 4½ to 6 inches long, and from 3 to 4 inches broad, cylindrical or elongated, flat at the ends, deep purple, smooth on the surface, and growing on the upper surface of the top branches.

1296. *Geography.*—This species of Picea is from India, as its name indicates, and is found abundantly in Bhootan on mountains at elevations ranging from 10,000 to 12,000 feet above sea-level. In Kamaoon it is found at from 7000 to 9000 feet of elevation, where it clothes the sources of the " Kosilla " in a forest of unusual gloom and thickness. It grows also on the easternmost range of the Himalayas, and also on the Choor and Kedarkanta Mountains, at elevations of from 8500 to 12,000 feet, and on all other ranges of similar heights, where the stems attain great height and girth—some of the trees on the Choor Mountains measuring 20 feet round at 5 feet from the ground, and upwards of 150 feet high, with the stem densely clothed with short branches, bearing but little proportion in length to the height of the tree. Introduced into Britain in 1837.

1297. *Description of tree.*—This tree is, generally speaking, quite hardy in Britain, but, like our common silver fir, it is disposed to start early into growth, and consequently it is very liable to have its young shoots injured by frost in the early part of the summer. It forms a handsome upright-growing tree, and is worthy of a place in every pinetum where it can have a northern aspect with a suitable soil. It can only be recommended as an ornamental specimen, however, as from its general characteristics it does not seem to be adapted ever to become a useful timber-tree in Britain.

1298. *Economic uses of timber.*—The timber of this species is soft and spongy, and evidently is not of a durable description. It is said to rot very quickly when exposed to the action of rain and sun.

1299. *Soil and situation.*—This species grows rapidly on any soil of a light loamy character, deep and porous, not sandy nor too dry, nor clayey nor cold-bottomed. It thrives better on a moderately elevated and dry site than on a low-lying and humid one, and on a western or northern aspect better than on an eastern or southern one. To preserve this species in health it requires to be shaded from the morning's and forenoon's sun, as when exposed to the direct rays of the sun before mid-day it starts early into growth, and consequently gets its shoots injured by frosts.

1300. *Propagation and culture.*—The seed of this species, like that of all the other newer Piceas, is very scarce, and to be had only in small quantities from time to time. It may be sown and the young plants treated in all respects as has been recommended for the *Picea bracteata.* This species also may be propagated by grafts and layers very readily.

1301. Specimens of this Picea are plentiful in the country, of heights from 20 to nearly 30 feet.

SECTION LX.—PICEA PINSAPO, OR THE SPANISH SILVER FIR.

1302. *Specific character.*—Leaves solitary, regularly and thickly disposed around the branches, short, ½ inch long, and placed at right angles to the branchlets, very stiff, sharp-pointed, flat on the upper surface, and with a central rib slightly marked on each side by two furrows, which forms the only and very superficial indication of the two silvery lines so strikingly conspicuous on the under side of the leaves in the silver fir tribe. Branches regularly in whorls on the main stem, very densely clothed with laterals even to their base, and scarcely extending any wider than those branches nearer, giving the tree a shape rather that of a cylinder than a pyramid; the young shoots also have a cylindrical shape on account of the leaves being so thickly placed at right angles all round the stem. Bark darker in colour and more scaly than that of the common silver fir. Cones erect, in great numbers on the upper part of the top branches towards their extremities, and without any footstalks, oval, cylindrical in form, terminating abruptly at the top, often with a small elevated point, from 4 to 6 inches long, and from 2 to 2½ inches broad. Bracteas small, concealed by the scales, and not extending beyond them.

1303. *Geography.*—This species is found in Spain on the mountains between Ronda and Malaga in Granada, and forming forests on the higher parts of the Sierra de la Nieve, at an elevation of from 4000 to 6000 feet. It abounds in all the higher mountains, particularly on the northern exposures, reaching even near the summits, where the snow lies at least four or five months in the year. It was introduced into Britain in 1838.

1304. *Description of tree.*—This species attains heights from 60 to 70 feet, with a dense branching head, forming a most beautiful tree at all stages of its growth. In its younger stages it resembles *P. cephalonica* very much. It may be easily distinguished from that species, however, by the different form of its leaves, which are broader, not so sharp, and are not twisted at the base as in *P. cephalonica.* It is a thoroughly hardy species, of a moderate rate of growth, and is by no means particular as to soil and situation. For the first few years of its growth the leading shoot makes but little progress, while the lateral branches grow vigorously, giving the tree a rather flat-headed and bushy appearance; but after it has got fairly established, the top shoot rises rapidly, and ere long grows up forming a tall tree of a cylindrical shape. It deserves a place in every park and pinetum, being hardy and very ornamental.

1305. *Economic uses of timber.*—The timber of this species is said to be of as good quality as that of the common silver fir, and to be full of resin, which is a good indication.

1306. *Soil and situation.*—This species seems to thrive well on most soils suitable to the common silver fir, but requires a situation not too high-lying nor exposed to high winds.

1307. *Propagation and culture.*—Seeds of this species are imported from Spain now and then through seed-merchants on the continent of Europe—not plentifully, however. Nurserymen in this country generally sow them in a cold frame for fear of any risk to the young plants, and protect them for the first winter or two, exposing them freely all summer. The young plants seem perfectly hardy, however, as we have not seen any of them injured by the frosts of our winters.

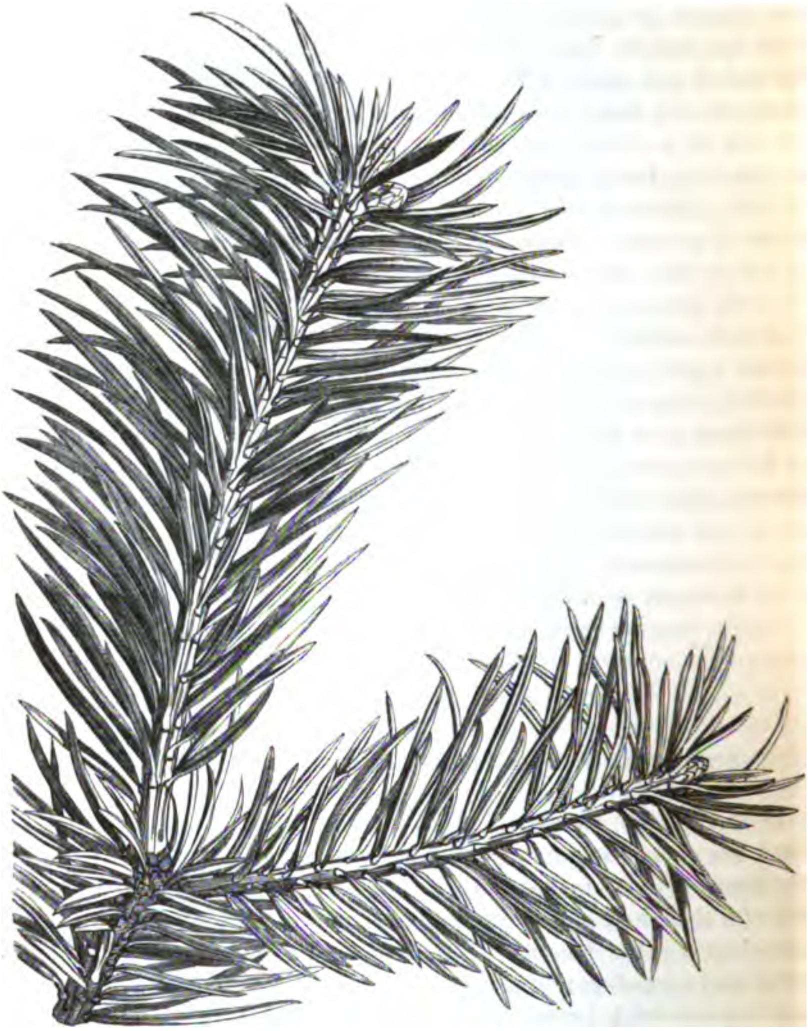
1308. Specimens of this beautiful Picea are to be found in many parts of the country, from 25 to 40 feet in height.

SECTION LXI.—PICEA WEBBIANA, OR WEBB'S INDIAN SILVER FIR.

1309. *Specific character.*—Leaves solitary, at first scattered all round the shoots, but finally more or less arranged in two rows laterally, from 1 to 2 inches long, linear, flat, leathery, bidented on the end, of a dark and glossy green above, and furnished with two broad white bands below (see fig. 129). Branches in regular whorls, horizontal and spreading; branchlets opposite, 2-rowed, and stout. Buds oval, covered with brown scales, and resinous. Cones solitary, erect, and of a rich purple colour, from 6 to 7 inches long, and about 2½ inches broad, cylindrical, blunt-ended, full of resinous matter, and growing on short stout footstalks on the upper surface of the top branches.

1310. *Geography.*—This also forms a noble tree, growing from 70 to 80 feet high at different elevations on the Himalayan Mountains. Its lowest limit on the southern slope of these mountains is about 10,000 feet. Dr Griffith says that this species is rare below 9500 feet in Bhootan, but constitutes vast woods at from 12,000 to 13,000 feet of elevation. Dr Hooker found it in Sikkim measuring 30 feet

Fig. 129.



in girth. It also forms extensive forests on the north side of the Shatool Pass, but on the south face it does not flourish. It was introduced into Britain in 1822.

1311. *Description of tree.*—This is, without doubt, one of the prettiest of the silver firs. It has more of the silver tinge on the lower side of the leaves than any other species of Picea, and this gives it a very marked character; indeed, it may readily be distinguished from all the other species by the very decided whiteness on the under side of the leaves. The tree forms a beautiful object when standing out on a well-shaded lawn; the dark and glossy green of the upper sides of the leaves, blending with the silvery white of the under sides, gives the foliage a cheerful and rich effect, contrasting pleasingly with the darker foliage of other coniferæ. The tree is quite hardy after it gets up to some age and size, but in all southern and eastern aspects the young shoots suffer from late spring and early summer frosts, from its tendency to start early into growth.

1312. *Economic uses of timber.*—The timber of this species is of inferior quality, and therefore the tree is not to be recommended as a timber-producing one.

1313. *Soil and situation.*—These are the same as stated in respect to *P. pindrow.*

1314. *Propagation and culture.*—The seeds of this species are generally sown in a cold frame, and the young plants protected during the first two winters. Plants of it may be readily propagated by grafting and layering.

1315. Specimens of Picea Webbiana, from 25 to 30 feet in height, are now common in pinetums in Britain.

SECTION LXII.—THE LARCH (LARIX)—LINNÆAN SYSTEM, MONŒCIA MONADELPHIA.

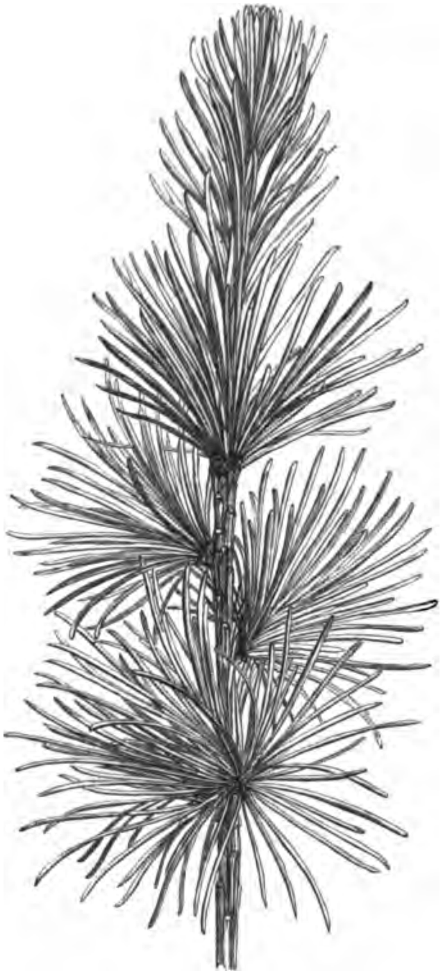
1316. *Character of the genus.*—Male catkins small, without footstalks, and egg-shaped; the female ones erect, solitary, ovate, and much larger than the male. Cones small, oval-obtuse, or somewhat cylindrical, and consisting of but few scales. Scales persistent, leathery, thin towards the margins, and a little reflected or undulated. Bracteas either longer or shorter than the scales, unevenly notched on the edges, ovate-pointed or lanceolate. Seeds very small, with a leathery covering and membranaceous wing. Seed-leaves from 5 to 7. Leaves deciduous, linear, obtuse, soft, without footstalks, and either produced in bundles or singly.

1317. There are several species of larch, all deciduous trees, some of them of large dimensions, natives of the mountainous regions of Europe and of Asia, and of the plains and hills of North America. As, however, there is only one species worthy of cultivation as a timber-tree in this country, we propose to confine our remarks to it. It is

LARIX EUROPEA, or the Common European Larch.

1318. *Specific character.*—Leaves in bundles, many together round a central bud, but singly on young plants and the leading shoots, deciduous, linear, soft, blunt or rounded at the points, spreading, slightly recurved, and of a beautiful bright and light green (see fig. 130). Cones of a longish oval shape, erect, of a brown colour, about 1 inch long, and remaining for a long time on the trees. Scales persistent or not falling off, roundish, streaked, and slightly waved on the margins. Bracteas generally longer than the scales, particularly towards the base of the cones. Seeds small, of an irregular oval form, with a broad wing. Seed-leaves from five to seven. Cones ripen late in the autumn.

Fig. 130.



1319. *Geography.*—The common larch is found occupying hilly regions in Central Europe, forming large forests on the Alps of France and Switzerland. Its proper region seems to be at a height of from 3000 to 6000 feet of elevation, although it is sometimes found as high as 7000 feet; but at the latter height the tree is much dwarfed. It is found also on the Carpathian Mountains in Tyrol and Hungary, but seldom on the German plains. It was introduced into Britain in 1629.

1320. *Description of tree.*—The larch is an open, airy, and graceful-looking tree, of a conical form, and in favourable situations attaining large dimensions, frequently from 80 to 100 feet, with stems from 3 to 4 feet in diameter. It generally forms a very straight stem, and where it has proper space for the full development of its branches, they clothe the stem from bottom to top in a graceful and pendant manner. There is one feature in this tree which distinguishes it from others of the coniferous tribe—namely, its shedding its leaves in the autumn of the same year in which they are produced. It is decidedly one of the most valuable of the coniferous trees yet introduced into this country, both in respect of the quick progress which it makes, and of the real value of its timber. Being a native of the mountainous districts of central Europe, it is found to endure the climate of the hilly districts of the north of England, and of the mountainous tracts in Scotland, as well as the Scots pine; but it is more particular with regard to the circumstances which favour its healthy growth than that tree. In the larch plantations of this country we have several varieties of the tree, some having white flowers, or female catkins, and some having red; while some have their timber of a whitish colour, and others of a reddish; and we generally find trees with their flowers and timber of all shades between white and red—these differences in the colour of the flowers and wood being no doubt caused by some accidental circumstances of soil, site, or impregnation.

1321. *Economic uses of timber.*—As to the durability of the timber of the larch, it is allowed by all who are at all acquainted with the tree, and who have had occasion to use the timber, to be decidedly the toughest and most lasting of all the coniferous tribe we are yet acquainted with. There is also a peculiar feature characterising the wood—namely, its being durable and tough when only of a few years' growth. Of this we have had ample proof from our own experience in erecting fences with young larches. Larch is extensively used for all purposes in our rural economy. Its durability makes it much sought after for mining purposes, and in these very large quantities of it are annually used—the demand for it, of small sizes, far exceeding the supply. For the purpose of railway sleepers there is an unlimited demand; this sort of wood being always preferred for that purpose when it can be had, as it is found to last longer than any other kind when laid on the earth in the shape of sleepers.

1322. *Soil and situation.*—The circumstances which we have found most favourable to the healthy development of the larch are: as to soil, it is not particular, but the roots must be in a soil deep and porous, which has been well cleansed by the free passage of water through it, and which has at the same time the benefit of being constantly kept clean and in a wholesome state by a good descent for the water that may fall upon it, either naturally or by means of well-made drains—as is particularly exemplified in the case of larches growing on all mountain-slopes, where there is a continual descent of water from the higher to the lower grounds. In the cultivated forest this can be imitated by good deep drainage. The larch does not succeed on thin lands, nor on those having a retentive subsoil. Therefore, in planting this tree, if the land be at all of a retentive character in the subsoil, it should be well opened up and made porous by a proper system of deep drainage, according to the rules laid down for drainage in its own place in this work. There can be no doubt that much of the disease in our larch plantations has arisen from imperfect drainage in the land on which the tree has been planted. For full information on the diseases of the larch, see section under that head. No tree we have—if we may except the Scots pine—is so hardy as the larch; therefore, as to situation, it may be planted at any altitude at which the Scots pine will prosper. Still it must be observed that on very high-lying sites with poor soils, the Scots pine is certainly the better tree to plant, both with a view to profit and to producing shelter.

1323. *Propagation and culture.*—The larch is propagated from seed in the same way as other coniferous trees. The speediest way to extract the seeds from the cones is to subject them to heat on a timber-kiln in the same way as recommended for extracting the seeds from the cones of the Scots pine; with this exception, however, that in drying the cones of the larch the heat should not on any account be raised above 105° Fahr. Even when the cones are subjected to heat on a kiln as stated, the seeds of the larch will not fall out as those of the Scots pine do, but will have to be thrashed out with a flail. On the kiln the cones will be merely dried and made brittle, and so prepared for extracting the seeds from them. After the cones of the larch have been dried on the kiln, they should be removed in the warm state and laid some 8 or 10 inches thick on a stone or pavement floor, on which they should be thrashed to pieces with flails, observing to sift out the seeds by means of a sieve from time to time, till the whole have been extracted. For the after culture of the larch, see chapter on the management of the nursery. As to whether foreign or home-grown seed should be used in our cultivation of the larch, we shall give our opinion, with our reasons for it, in a subsequent section of this work.

1324. On most of the old established properties in Britain, and especially in Scotland, good specimens of the larch are so plentiful that we think it would be superfluous to refer here to those on any particular place. Suffice it to remark, that on many places this tree is found of heights from 80 to over 100 feet, with stems from 3 to 4 feet in diameter.

SECTION LXIII.—THE CEDAR (CEDRUS)—LINNÆAN SYSTEM, MONŒCIA MONADELPHIA.

1325. *Character of the genus.*—Male catkins solitary, cylindrical, erect, and terminal; female ones somewhat oval and obtuse, solitary, very rarely in pairs, and erect. Cones oval, obtuse at the ends, quite smooth, erect, and on the upper side of the branches. Scales very closely placed, rounded on the outer margins, quite thin at the edges, leathery, smooth, and more or less deciduous. Seeds in twos under each scale, with a soft tegumental covering, full of turpentine, more or less angular, and furnished with a large persistent membranaceous wing. Seed-leaves mostly nine in number. Leaves needle-shaped, somewhat 4-sided, stiff, persistent, and disposed either in bundles or solitary.

1326. The cedars are all trees of a majestic character, are evergreen, and highly ornamental in whatever place they are found. They are natives of Mount Lebanon, the north of India, and the Barbary and Atlas Mountains in northern Africa, and all of them are perfectly hardy in Britain.

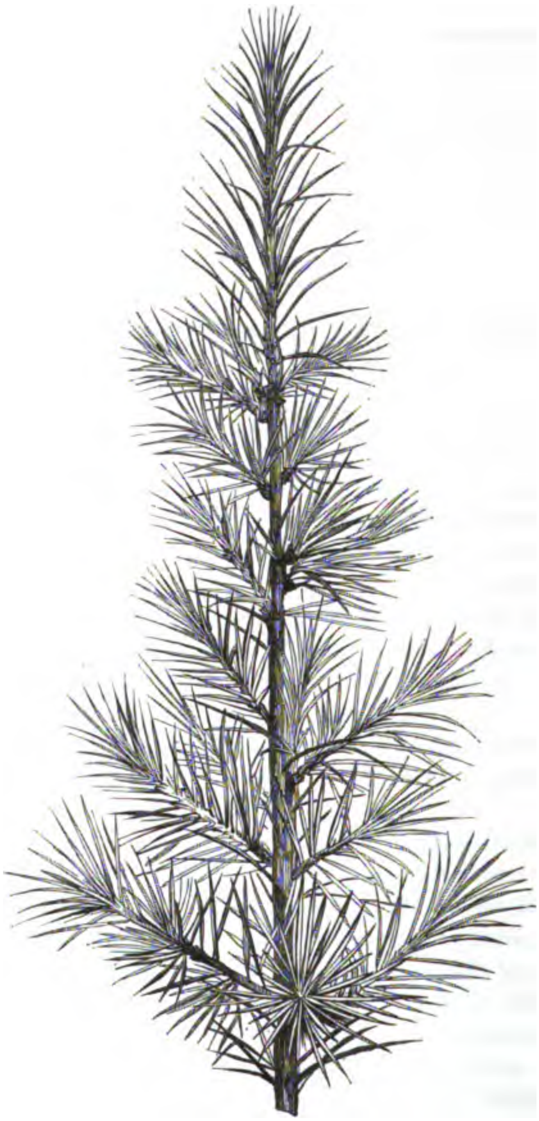
SECTION LXIV.—CEDRUS LIBANI, OR THE CEDAR OF LEBANON.

1327. *Specific character.*—Leaves simple, very dense, in alternate tufts, of about thirty in number, evergreen, rigid, partially 4-sided or cylindrical, tapering to the point, straight, 1 inch long, sharp-pointed, and of a dark grass-green colour (see fig. 131). Branches horizontal, with the branchlets disposed in a flat, fan-like manner on the branches, very numerous, and thickly set with leaves. Cones erect, ovate, flattened at the ends, and depressed, 4 to 5 inches long, and 2½ inches wide, with rather a long footstalk, of a greyish-brown colour, and remaining firmly attached for years to the branches. The cones require two years to ripen, and exude a large quantity of resinous matter while growing.

1328. *Geography.*—This well-known species is a native of Mount Lebanon in Syria, and was introduced into Britain about the year 1683.

1329. *Description of tree.*—The cedar of Lebanon is perhaps the most majestic-looking tree we have. There is no tree that has stamped upon it so decidedly an expression of majesty and grandeur. The oak is certainly a noble and admirable tree in its general outline and bearing: the pine, and the larch, and the fir, are tall and stately specimens of the vegetable kingdom; but when these are compared with the broad massive exhibition of branches and grand expression of a full and well-grown cedar of Lebanon, they seem tame, and lose in our eyes even the effect they had before comparison. In short, as an ornamental tree this is, in our opinion, superior and preferable to all others we have in this country. It throws out lateral branches of great size in proportion to the height; and even after it has attained its height, the branches continue to extend till the full-grown tree presents a head with a broad and flat surface. This is the character of the tree when it is found standing alone with free room all round; but if it be at all confined among other trees, it rises with an upright stem like any tree of the pine tribe. Its place is as an ornamental specimen in parks; and for this purpose no tree we have is better fitted to produce a grand effect.

Fig. 131.



1330. *Economic uses of timber.*—The timber of this tree, although said to be of great durability when grown on its native mountains, is but soft and of a secondary class as grown in Britain, and is not nearly so valuable as that of many of our pines and firs. It is not to be recommended as a timber-producing tree, therefore, but merely as an ornamental one.

1331. *Soil and situation.*—This tree is exceedingly hardy, and never suffers from any degree of cold in our climate. It is in no way particular in regard to soil, provided always that is dry, deep, and of an open and porous bottom. In short, it will grow well in any soil suitable for our ordinary forest-trees.

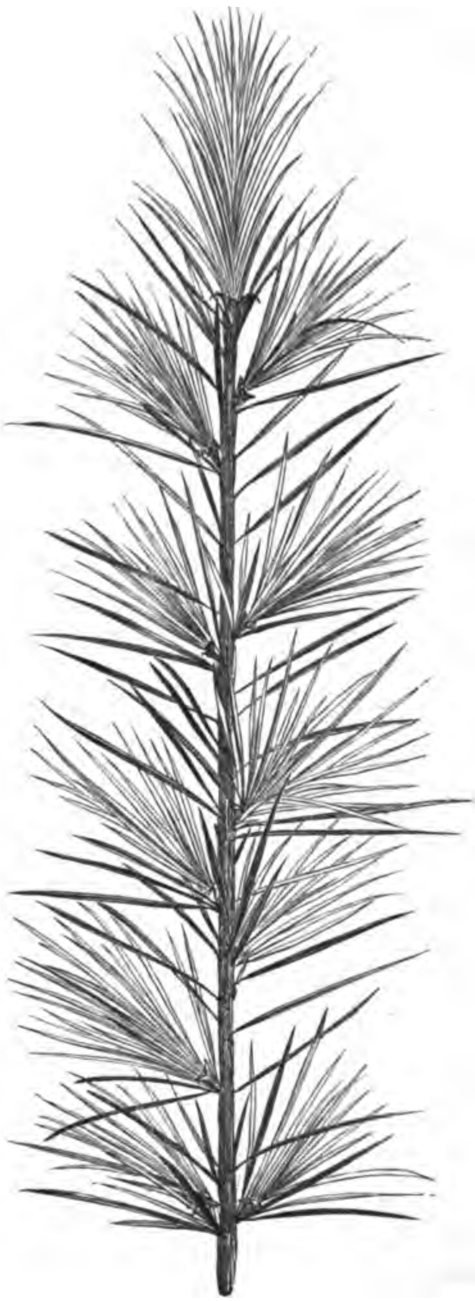
1332. *Propagation and culture.*—This tree does not begin to bear seed till it has attained considerable age and size—seldom before it is from 50 to 60 years old. When the cones are ripe they do not fall off the tree at an early stage like those of many other cone-bearing trees, but remain attached to the branches for several years, with all their seeds in them. When the seeds are wanted from home-grown trees, the cones should be gathered in spring, and the seeds extracted immediately after; or if the cones are procured from the Levant, they may be laid past in a dry airy loft till the time of sowing has arrived. British nurserymen are supplied with both home-grown and foreign seed. The seeds should be sown in April, in any piece of light and well-prepared ground, and placed on the bed about an inch apart; and the covering of earth should not be more than five-eighths of an inch. The plants will spring up about five or six weeks after sowing, according to the state of the weather. Afterwards they may be dealt with in all respects as recommended for the Scots pine; that is, the seedlings should be transplanted into nursery-rows when one year old, there to remain till they are of sizes fit to transplant out into their permanent sites. Many, however, plant a large portion of them into small pots when one year old, and shift them into larger as they make progress and require more root-room, as by growing a part of the plants in this way, their removal can be effected at any time of the year, as they may be wanted.

1333. Perhaps the finest trees of this species to be found in Britain are at Sion House: there, there is one over 80 feet high, with a stem 8 feet in diameter; at Claremont, near London, there is a specimen about 100 feet high, with a stem considerably above 5 feet in diameter; at Hopetoun House, the seat of the Earl of Hopetoun, near Edinburgh, there are several fine cedars of Lebanon—one especially is about 80 feet high, and nearly 7 feet in diameter of stem. Even in the north of Scotland there are some fine trees of this species. At Beaufort Castle, the seat of Lord Lovat, in Inverness-shire, there is one which measures about 6 feet in diameter of stem, with a height of fully 60 feet.

SECTION LXV.—CEDRUS DEODARA, OR INDIAN CEDAR.

1334. *Specific character.*—Leaves evergreen, somewhat 4-sided, needle-shaped, acute-pointed, pungent, very glaucous, and from 1 to 2 inches long; those on the principal and lateral branches being collected in tufts or close bundles of from thirty to sixty in number, on very short and numerous branchlets, while those on the young shoots are solitary, alternate, and scattered along the twigs; when young very glaucous, but getting much greener as they get older (see fig. 132). Branches very stout, irregularly placed along the stem, much divided, horizontal, and quite flat, the lower ones being more or less deflected and close to the ground. The general aspect of the tree when young is drooping and very graceful, but as it grows older and larger the branches assume a stiff, flat, and solemn appearance, like that of the cedar of Lebanon. It flowers in September, and the seeds are ripe in October or November of the following year, or in about thirteen months. The male catkins, though solitary, are very numerous, erect, 2 or 3 inches long, at first oval, but gradually become cylindrical; the majority of these and the female flowers are produced on separate trees, but a considerable number of these trees also produce both male and female flowers on the same individual. In about a month after the deodar has flowered, the young cones, covered with a bluish bloom, appear of a cylindrical form, without any footstalks, and solitary on the top of the little tufts of leaves. Cones erect, solitary on the upper side of the stout top branches, ovate, obtuse, or nearly cylindrical, from 3 to 5 inches long, and 2½ inches wide, flat, and slightly depressed at both ends, and very much resembling those of the common cedar of Lebanon, of a rusty-brown colour, and when the seeds are ripe, break up and fall to pieces, shedding both scales and seeds on the ground.

Fig. 132.



1335. *Geography.*—The deodar occupies a great range on the Himalayas, and is found flourishing at from 5000 to 12,000 feet of elevation, mixed with, for the first 1500 feet, *Pinus longifolia;* while for the last 3000 or 4000 feet of elevation it is found along with *Abies Smithiana* and *Picea pindrow.* It is found on all the higher mountains from Nepal up to Cashmere; and Dr Griffith describes it as occurring in vast forests and of great size towards Kaffristan, where it flourishes at an elevation of from 6000 to 10,000 feet above the level of the sea. In the lower Kamaoon, Major Madden measured one tree in 1830 which was fully 36 feet in circumference near the base; and he saw several on the northern declivity of the Boorum and Roopin Passes not less than 30 feet in girth, and from 150 to 200 feet high. It was introduced into Britain in 1822.

1336. *Description of tree.*—This tree is readily known from the cedar of Lebanon by its drooping habit of branches, especially in its younger stages, and by its lighter appearance. The cedar of Lebanon has a dark-green aspect, and is strong, firm, and horizontal in the spread of its branches, even while young; whereas the Indian cedar has an appearance quite the opposite of this, and, besides, is at all stages of its growth a more free grower. As it becomes older, however, it gradually assumes very much of the character and outline of the cedar of Lebanon, its branches becoming stiff and flat like those of that species. Judging from the best specimens we have in this country, it is perhaps as ornamental in its habit of growth and in the display of its branches as the cedar of Lebanon is, but not so imposing and grand. The weeping habit of its branches gives the tree, in its younger stages, a more graceful aspect than the other, but this detracts from it in point of grandeur and majestic effect. Still, all travellers who have seen the tree full grown in its native mountains, agree that it is a tree of majestic and imposing effect, and that it unites those qualities with beauty and gracefulness. All this we are quite prepared to accept, as even in the case of the oldest trees we now have in this country—upwards of fifty years' standing—it is, like its sister cedar, a tree not surpassed by any in an ornamental point of view.

1337. *Economic uses of timber.*—The timber of this tree is said to be highly valued by the inhabitants of the country from which it comes. We have ourselves seen timber which was taken from a full-grown tree in India; and certainly, judging of it from the specimen we saw, we should say that the timber is of first-rate texture, and deserving of the character it has got in its native country. But whether, grown in this country, even when it shall have arrived at maturity, it will produce timber equally or nearly as good, remains to be seen; and ere we can judge of this many years will have to elapse.

1338. *Soil and situation.*—This cedar is by no means of a delicate constitution in respect to soils, for we have it growing on soils of every description, from those of a light sandy character to others of a strong clayey nature. In all cases, however, the soil should be of a dry and well-cleansed character—not retentive in the bottom, nor cold or sour. Indeed on cold-bottomed lands, or on those that are thin and lying on a retentive subsoil, the tree sickens and dies at an early stage. Therefore, where this tree is wanted to prosper, the land must be made deep, porous, and dry by drainage, if it is not naturally so. The tree likes a free and open exposure, and is well suited to grow on sites of moderate elevation, if the soil on which it is planted be dry and deep enough for its roots to spread in.

1339. *Propagation and culture.*—Young plants of this species are reared from seeds in the same way as has been stated in respect to the propagation of the cedar of Lebanon. Some of the oldest trees in the country have already borne cones; particularly those at Dropmore, at Sunning Hill, Knaphill, Chiswick, and several other places in the south of England. Considerable supplies of seeds are obtained from the native forests in India from time to time, but still it is far too scarce to admit of the plants being reared abundantly and cheap; and until a greater supply of seed can be had from India than is now obtained, this tree will not be planted extensively in our woods.

1340. Good specimens of this cedar are now plentiful in the country, many of them having attained heights of from 45 to 60 feet, with stems in proportion.

SECTION LXVI.—CEDRUS ATLANTICA, OR THE MOUNT ATLAS CEDAR.

1341. *Specific character.*—Leaves in tufts, or singly, on the young shoots, stiff, needle-shaped, cylindrical, or flattened on the upper side, sharp-pointed, and straight; evergreen, with a silvery appearance, and shorter and denser than those of the common cedar of Lebanon; very irregular in length in the fascicles, varying from ½ to ¾ inch longer on the leading shoots, and with a furrow running along the whole length of the leaf. Branches rather slender, less rigid, and covered with scattered bundles of leaves, mostly opposite, but sometimes very irregularly placed. Cones ovate, flattened, or rather depressed at the ends, from 2½ to 3 inches long, erect on the upper side of the external branches, of a shining light-brown colour, and full of resinous matter.

1342. *Geography.*—This tree is found on the highest mountains in Barbary, particularly on the famous Atlas range in northern Africa, at an elevation of from 7000 to 9000 feet, in great abundance, and is quite hardy and more rapid in growth than the common cedar. It was introduced into Britain in 1843.

1343. *Description of tree.*—This tree is readily known from the cedar of Lebanon by its more upright and free habit of growth, and from the Indian cedar by its never assuming the peculiar pendulous habit which that tree does. In the young state, however, it very much resembles the cedar of Lebanon, and by the inexperienced eye may be readily mistaken for it; but the more upright, open, and free-growing habit at once distinguishes it. Comparing the cedar of Lebanon with it, say in the case of young plants of some five years old, the average height of the former may not exceed 18 inches, while that of the latter will be at least 30 inches. The tree seems as hardy as the Indian cedar, and deserving of being extensively cultivated in our parks and pinetums. Although very hardy, in the general sense, of cold, still, like the *Cedrus deodara*, it does not stand well against high winds. In a situation where it is exposed to prevailing winds, its progress is slow, and it takes a stunted habit. In planting it, therefore, it should not be carried out to sites where it is likely to be exposed to storms of winds. In all other respects, however, it is perfectly hardy and free-growing.

1344. *Economic uses of timber.*—At the present stage of the growth of the tree with us we cannot say much as to what the quality of its timber is likely to be when matured in our climate. If we may pass an opinion on the subject at present, we would say that its timber is not to be of so durable a description as that of the *deodara.* Still it may turn out useful for many purposes.

1345. *Soil and situation.*—These are in all respects the same as has been stated in reference to the *Cedrus deodara.*

1346. *Propagation and culture.*—This species is propagated from seed in the same way as has been stated for the propagation of the cedar of Lebanon. Seeds are to be had now and then, and are comparatively plentiful.

1347. There are now many fair specimens of this cedar in the country, ranging in height from 30 to nearly 50 feet, with proportionate stems.

SECTION LXVII.—THE YEW (TAXUS)—LINNÆAN SYSTEM, DIŒCIA MONADELPHIA.

1348. *Character of the genus.*—Fruit solitary and one-seeded. Disc a fleshy open cup, and viscid. Seeds nut-like, with a bony shell, free, and exposed on the upper part. Leaves linear, decurrent, and alternate. Seed-leaves in twos, and very short.

1349. The yews are low evergreen trees or bushes, found in the temperate parts of Europe, Asia, and America. We propose to refer to one species only, the common yew, as in Britain it is a common tree, sometimes attaining considerable dimensions of timber.

TAXUS BACCATA, or the Common Yew.

1350. *Specific character.*—Leaves in two rows, crowded, linear, slightly curved, or falcate, pointed, flat, entire, and slightly revolute on the margins; from ¾ to 1¼ inch long, and 1½ line broad, of a dark shining green above, much paler below, with a prominent midrib, terminating in a small point at the apex. Branches spreading, much divided, and dense. Branchlets long, slender, and drooping. Male flowers axillary. Berries rounded, glutinous, drooping, open at the top, and enclosing a brown, oval, partially naked nut, unconnected with the fleshy disc, which is of a scarlet colour, and sweet. Seed-leaves in twos.

1351. *Geography.*—The common yew is found in most parts of Europe, at elevations ranging from 1000 to 4000 feet. It is frequently met with on the Apennines and the Alps, in Greece, Spain, the Pyrenees, and the Caucasus, and also in Britain.

1352. *Description of tree.*—The common yew-tree rises from the ground with a short but straight stem, which, at the height of 3 or 4 feet, sends out very numerous and spreading branches, forming a dense head, usually, when full grown, from 30 to 40 feet in height, and always characterised, till the tree attains a great age, by the tuftings and sky outline being pointed or peaked; though, after the tree has begun to decay, these become rounded or stag-headed. The stem and branches are channeled longitudinally, and are generally rough from the protruding remains of shoots which have decayed and fallen off. The yew is of slow growth, but in favourable situations it will attain the height of from 6 to 10 feet in 12 years from the seed. The yew-tree attains a great age, some of them in this country being well known to be about 1000 years old.

1353. *Economic uses of timber.*—The wood of the yew is very hard, close, and fine-grained, flexible, elastic, splitting readily, and of great durability. It is allowed to be of the best description for cabinetmaking purposes. It is also very durable for country fencing purposes; so much so, that in some parts of England where it is plentiful, there is a common saying that a paling-post of yew will outlast a post of iron.

1354. *Soil and situation.*—The yew will grow on most soils, if not too sandy and dry. It seems to thrive best on strong loams, and succeeds well even on strong clay lands, and it prefers a situation rather sheltered, and does not dislike the shade of other trees if they do not overtop it.

1355. *Propagation and culture.*—The yew is propagated from seed, except its varieties, which are propagated from cuttings. The seeds are ripe in October, and should then be gathered and cleared from the pulp by washing them. The seeds removed from the pulp in this way should afterwards be mixed up with about twice their bulk of sand, and laid in a pit for fourteen or fifteen months, when they may be sown in beds on any good loamy soil, and covered to about five-eighths of an inch in depth. When the plants have stood two years in the seed-beds they should be transplanted into nursery-rows.

1356. There are many remarkable yew-trees throughout the country, both in England and Scotland. At Sion House there are some fine old specimens; and in the Forest of Dean, and in the New Forest, there are many remarkable specimens, which had been young and growing trees in the days of William the Conqueror. At Temple Farm, Corsley, Wilts (Marquis of Bath), there is a fine old specimen upwards of 1000 years old. It is 50 feet high, with a diameter of stem about 10 feet, and of the head upwards of 50 feet. In short, most ancient places, whether in England or Scotland, have their specimens of old and interesting yews, many of them having a connection with the history of the respective places.

SECTION LXVIII.—THE CYPRESS (CUPRESSUS)—LINNÆAN SYSTEM, MONŒCIA MONADELPHIA.

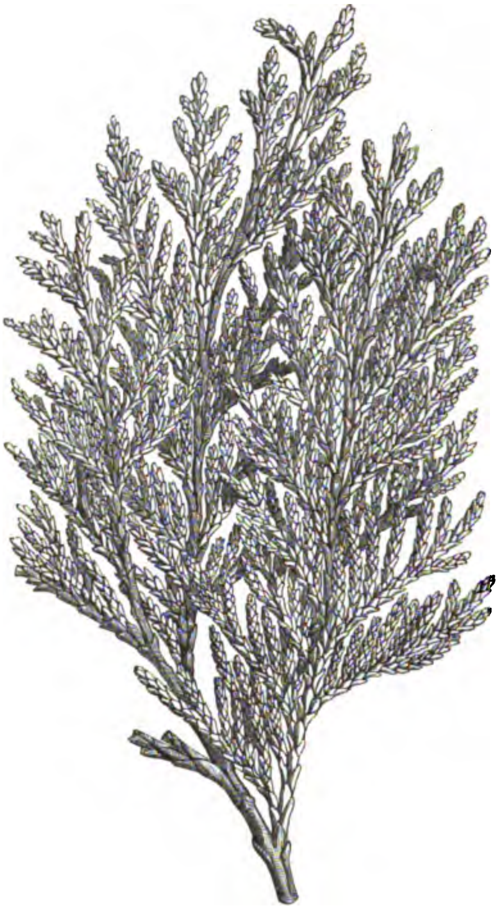
1357. *Character of the genus.*—Male catkins cylindrical and numerous, female ones roundish, and either in clusters or solitary. Cones somewhat globular, and composed of angular, irregularly shaped, woody scales, externally shield-shaped. Scales, from 6 to 10 in number, irregularly four or five sided, raised in the centre, and terminating in a more or less curved point. Seeds numerous, inserted on the upper interior surface of the scales, angularly compressed or ovate, with a bony covering, extending into a membranaceous wing at the margins. Seed-leaves in twos or threes, rarely in fours, but mostly in twos. Leaves scale-formed, regularly and closely imbricated in four rows.

1358. The cypress tribe are all large trees or bushes, found in the south of Europe, China, California, Mexico, Guatemala, North America, and the East Indies. In this family the leaves along the branchlets are mere scales, closely overlapping each other, and generally in four rows, with the branches always scattered along the stem, and the buds not scaly. The cones are always more or less of a round shape, small, and composed of from 6 to 10 woody scales, each having a projecting point in the centre; and when the seeds are ripe, the scales become dry and separate. All the species exude resin, but afford no turpentine.

SECTION LXIX.—CUPRESSUS LAWSONIANA, OR MESSRS LAWSON'S CYPRESS.

1359. *Specific character.*—Leaves on the adult plants ovate, in alternate opposite pairs, closely pressed, in four imbricated rows, and of a glaucous-green colour (see fig. 133); while those on the young plants are lanceolate, sharp-pointed, spreading at the ends, whitish at the margins, and frequently furnished with a small gland on the back. Branches crowded, flexuose, and more or less ascending. Branchlets very slender, flattened on the upper and lower surfaces, much divided, bending alternately inwards and outwards, and thickly covered with decurrent leaves in alternate opposite pairs, closely pressed together on the adult plants, but spreading on the younger ones. Cones solitary, terminal, many-sided, of a light-brown colour, covered with a glaucous bloom when young, and about the size of a large pea, or rather a short footstalk. Scales mostly 6 in number, but sometimes more, flat, with a rough external surface, of a corky texture, light brown, and irregularly four or five sided, with an elevated straight point in the centre. Seeds somewhat ear-shaped, rather large, and mostly three under each scale.

Fig. 133.



1360. *Geography.*—This fine species of *Cupressus* is found in the Shasta and Scots valleys, and, according to Mr Murray, along the banks of streams in a valley in the mountains of northern California, in lat. 40° to 42°, where it formed the handsomest tree he had seen. It was introduced in 1854.

1361. *Description of tree.*—The beauty of the foliage of this tree, together with its gracefulness of habit, and its hardiness, have established this species as one of the most suitable of the genus for ornamental purposes in Britain. It forms a fine tree, rising to about 100 feet in height, with its stem 2 feet in diameter. The branches first curve upwards like those of the spruce fir, and then hang down at the ends like ostrich-feathers.

1362. *Economic uses of timber.*—Of course we have not had the tree long enough in the country to have specimens of sufficient size of timber to enable us to judge of the qualities of the wood; but it seems of a compact and close-grained description, and somewhat resinous.

1363. *Soil and situation.*—This species of cypress is perfectly hardy, and seems to grow well on most soils and situations. We have seen it growing healthily, and making shoots of fully 12 inches in each year, on soils varying from a light sandy loam to a heavy clay loam, and some of them on situations that might be called exposed, being more than 800 feet above sea-level, and by no means sheltered,—thus proving that the tree is hardy and accommodating, and adapted to most soils and situations not wet nor too much exposed. To have the tree prosper well, however, it should be planted on a good dry loam, and in a situation sheltered rather than otherwise.

1364. *Propagation and culture.*—Seeds of this cypress are imported from time to time, and many of the older trees in this country produce cones with fertile seeds, so that now the species is by no means scarce. It is very readily propagated by cuttings, and some nurserymen raise a large proportion of their plants in this way, as in rearing it from seed there is generally considerable diversity to be found among the seedlings, and only a portion of them come quite true to the normal character of the species.

1365. There are now many fine specimens of this cypress in both England and Scotland, of heights from 20 feet to about 30 feet.

SECTION LXX.—CUPRESSUS SEMPERVIRENS, OR THE UPRIGHT CYPRESS.

1366. *Specific character.*—Leaves imbricated, in four rows, small, deep, shining green, closely pressed to the stem, convex, blunt, or pointed on young plants, and persistent. Cones large, globular, 1 inch or more in diameter, with numerous large angular scales, slightly convex, and mucronate in the centre, becoming woody, and separating when ripe. Seeds numerous under each scale, yellowish brown, and irregularly angular, and covered with a thin membranaceous skin.

1367. *Geography.*—The upright or common cypress is a native of Greece, Asia Minor, Persia, and probably the south of Europe. It is cultivated in all the countries on the Mediterranean, in Italy, Sicily, and Turkey. It was introduced into Britain in 1548.

1368. *Description of tree.*—In its native countries this tree attains heights of from 70 to 90 feet, with proportionate stems, but in Britain it is seldom found above 40 feet. It is a pretty evergreen tree, growing with all its branches in an upright direction, closely pressed to the stem, like those of the Lombardy poplar. The erect habit of this tree gives it a striking character when found standing among trees of a spreading habit, and on this account it is very often found in that position in parks and lawns. When young the plants are somewhat tender and impatient of frost; but as they attain age and consequent firmness and maturity of fibre, they become perfectly hardy, and stand our climate well on dry and airy sites, but on low-lying and humid situations the tree does not always ripen its wood well, and is on such sometimes less or more injured by frosts. Still the tree is sufficiently hardy to grow well on all dry and favourable sites not much exposed.

1369. *Economic uses of timber.*—Perhaps there is no tree produces more durable timber than this one; as in old buildings in Italy it is known to have stood from 600 to 1000 years, and still sound. In this country we have not had experience of its durability, but it is of common use in Candia and Malta, where it is considered the most durable of all timber.

1370. *Soil and situation.*—The soil on which this tree thrives best is a deep *dry* sandy loam, with a free exposure to light and air, but not exposed to prevailing winds or storms. It thrives on any soil that is moderately light and dry, although somewhat exposed; but, as already stated, low-lying and humid sites are very unfavourable for its healthy development.

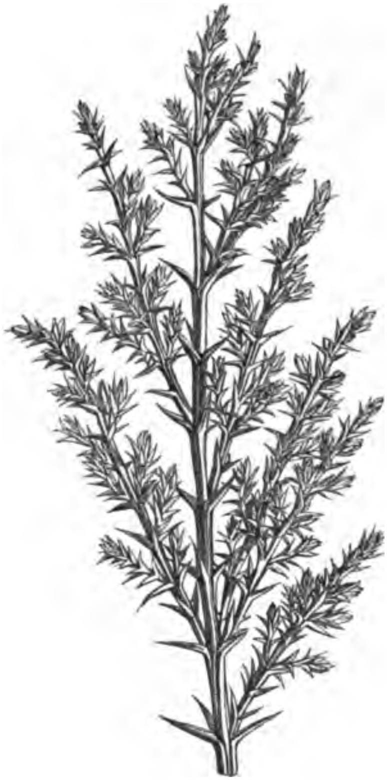
1371. *Propagation and culture.*—The seed of this species ripens in Britain, and the cones may be gathered early in spring. They are generally opened by subjecting them to a heat of about 100° Fahr., when the seeds readily fall out. They should be sown about the middle of April, on a rather warm-lying site, and on a light well-prepared piece of ground. The young plants will come up in about six weeks after sowing them. They should be protected during the first winter, as while they are young and soft they are liable to be injured by frost. The plants should be planted out into nursery-rows when one-year's seedlings, and they should be transplanted two years afterwards, in order to maintain and encourage fibrousness in their roots, before removing them to their permanent sites.

1372. Specimens of the upright cypress are common in the country, from 30 to 40 feet in height.

SECTION LXXI.—CUPRESSUS MACROCARPA, OR LARGE-CONED CYPRESS.

1373. *Specific character.*—Leaves ovate, imbricated, in four rows, bright grass-green, and closely set upon the old plants; they are expanded, awl-shaped, sharp-pointed, and thickly set upon the young plants (see fig. 134). Branches irregularly spiral, but sometimes alternate or opposite; younger ones and laterals opposite, dense, and quite green; older branches dark brown, and nearly horizontal from the main stem. Cones in clusters of three or four together, oblong, from 1 to 1½ inch long, and nearly 1 inch broad, with ten scales, the larger dark brown, and more or less angular. Seed-leaves in fours, but sometimes only in threes. Seeds angular.

Fig. 134.



1374. *Geography.*—This species is a native of the wooded heights near Monterey, in Upper California. Mr Hartweg found it there forming a tree 60 feet high, with a stem 9 feet in circumference, and with a far-spreading, branching, flat top, like a full-grown cedar of Lebanon, which he says it very much resembles when old. It was introduced into Britain in 1838.

1375. *Description of tree.*—This species is sometimes found in nurseries and pinetums under the name of *C. Lambertiana;* but Gordon, in his 'Pinetum,' says that the two are the same plant. He says: "That there is some difference in the shape of the plants may be, but then it arises from nearly all of those plants known under the name of *C. Lambertiana* being raised from cuttings, while all those called *C. macrocarpa* are seedling, and have a more pyramidal shaped head, while the cutting plants (*C. Lambertiana*) have a horizontal and rather flat-headed appearance." I note this here to put the young forester on his guard in respect to the two names given this species. This species forms a fine tree, remarkable for the lively grass-green of its foliage. It is a rapid-growing tree when young, but its growths diminish as the tree attains age. It does not take on its horizontal character till of considerable age, and then it assumes the cedar character referred to. It is quite hardy, even in Scotland, when planted on proper dry and airy sites; but on low-lying and humid situations it is very liable to be injured by severe frosts. It may not be considered so hardy as *C. Lawsoniana;* still it has stood well on all dry and airy sites, and has suffered only on low-lying and damp ones, where its young wood had not become properly matured from too luxuriant growth.

1376. *Economic uses of timber.*—We cannot give any particular statement as to the character of the wood of this species.

1377. *Soil and situation.*—This species thrives best on the same description of soil and site which has been stated in respect to the *C. sempervirens;* that is, it thrives best on dry ground, and on moderately airy situations, but should not be planted on low-lying humid situations, as on such it is liable to be injured by frosts, in consequence of its growths being imperfectly ripened. We may add in regard to this species, that it thrives better in a favourable part of the country bordering on the sea than it does on situations far inland. Indeed the sea-breeze seems favourable to the growth of this species. On high-lying inland sites it does not prosper.

1378. *Propagation and culture.*—This species may be propagated from seed in the same way as described for the propagation of *C. sempervirens.* It may be propagated also by cuttings, as is very often done in the absence of seed; but plants reared from seed are always preferable to those reared from cuttings.

1379. Fine specimens of this cypress are now plentiful in the country, of heights from 30 to over 40 feet.

SECTION LXXII.—CUPRESSUS NUTKAENSIS, OR THE NOOTKA SOUND CYPRESS.

1380. *Specific character.*—Leaves in four rows, in opposite pairs, broadly ovate at the base, sharp-pointed, and ⅛ inch long, very thick, smooth, of a glossy green, sometimes a little glaucous when young on the upper side, and pale dull green below, convex on the back, decurrent, and closely adhering at the base; adult ones much shorter, awl-shaped at the points, keeled on the back, without any gland, but furrowed and closely imbricated; those on the young plants glaucous, somewhat lanceolate, quite straight, extending at the points, loosely imbricated, and bristle-pointed. Branches round, spreading, or curved upwards towards the ends, but sometimes those near the bottom of the trees are more or less deflected, scaly from the withered leaves, and of a brownish colour; lateral ones in two rows, regularly placed alternately on each side, flat and flexible; branchlets in two rows, 4-sided, rather distant, extended, and thickly covered with short, straight, regularly imbricated leaves. Cones solitary, globular, almost sessile, or on the ends of very short, scaly branchlets, about the size of a large pea, and covered with a glaucous bloom. Scales small, rough, and from six to eight in number, embossed, shield-shaped, with four or five angular or orbicular sides, elevated in the centre, in alternate opposite pairs, furnished in the middle with a straight, thick, conical, obtuse point, the lower pair much the thinnest, and very closely inserted at the base. Seeds mostly three under each scale, freely inserted on the interior of the upper surface of the scales, flat, and ear-shaped, with a bony shell along each side, and a membranaceous wing, frequently much broader than the seeds, and cut more or less sloping to the bottom.

1381. *Geography.*—This species is found along the north-west coast of North America, and particularly at Nootka Sound, in Observatory Inlet, and on the island of Sitcha. It was introduced into Britain in 1850.

1382. *Description of tree.*—This species a good deal resembles *C. Lawsoniana*, but may be easily distinguished from it by having yellow instead of crimson coloured male catkins, and, besides, it has a much more robust appearance, and is not so graceful in its growth as *C. Lawsoniana*. It may also be distinguished from *C. Lawsoniana* by the scales of its cones being from six to eight in number, while those of the cones of *C. Lawsoniana* seldom number more than six. The foliage of this species is also harder, and of a paler green, than that of *C. Lawsoniana*, and the plants are, generally speaking, not so well clothed with foliage. It is perfectly hardy—perhaps the hardiest species of Cupressus we have; is said to grow to a large-sized tree, and is deserving of a place in every park and pinetum.

1383. *Economic uses of timber.*—As to the timber of this species we cannot, in the present stage of the tree in this country, venture further than a mere conjecture.

1384. *Soil and situation.*—This species seems to grow well on most soils which are not wet, and on most situations not too high and exposed. In short, it is a very accommodating tree, and may be safely and successfully planted wherever our common hard-wooded trees are found to succeed.

1385. *Propagation and culture.*—This species may be propagated from seeds or from cuttings, in the same way as has been stated for the propagation of the other species.

1386. Specimens of this species are to be found in most pinetums in the country, from 20 to 25 feet high.

SECTION LXXIII.—THE AMERICAN ARBOR VITÆ (THUJA)—LINNÆAN SYSTEM, MONŒCIA MONADELPHIA.

1387. *Character of the genus.*—Male catkins oval, the female ones solitary and terminal. Cones ovate-oblong, solitary, terminal, leathery, and smooth, with a projecting tubercle below the apex of each scale. Scales from four to six in number, in opposite pairs, and mostly unequal in size. Seeds in twos at the base of each scale, and furnished with a transparent wing. Seed-leaves in twos. Leaves in opposite pairs, very small, scale-like, imbricated, compressed, and in four rows (see fig. 135).

The Thujas are all large evergreen trees or shrubs, found in North America and California.

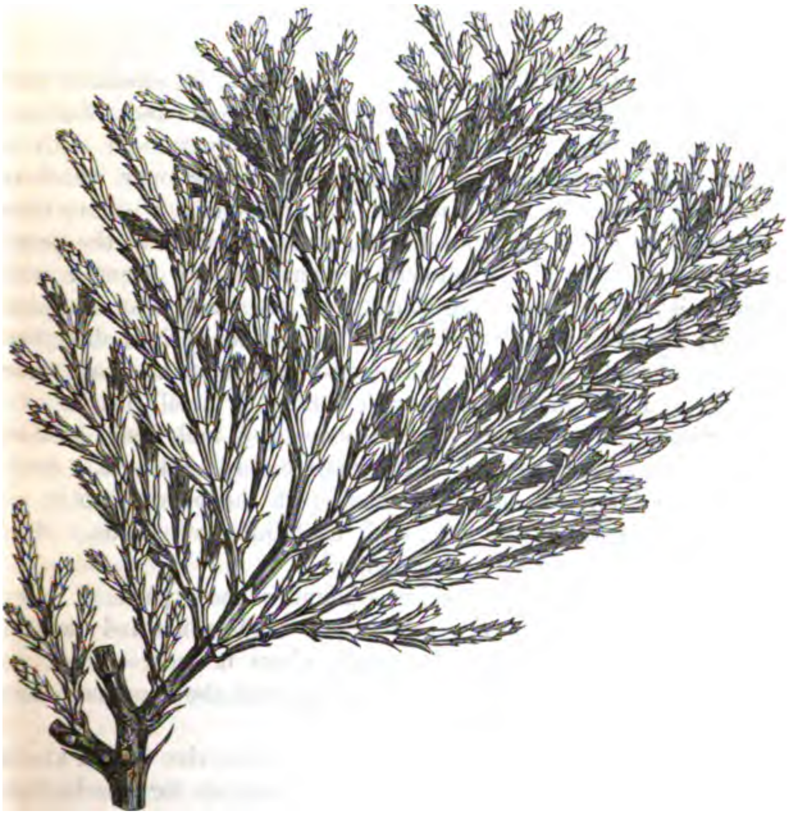
SECTION LXXIV.—THUJA GIGANTEA, OR THE GIGANTIC ARBOR VITÆ.

1388. *Specific character.*—Leaves in alternate opposite pairs, closely imbricated, and without any gland on the back; those on the branches are more distant, enlarged at the base, decurrent, and tapering to an acute point, while those on the branchlets are very flat, closely placed, regularly imbricated, in four rows, much shorter, more rounded, and furnished with a short spiny point, the marginal ones being more or less lanceolate, bristle-pointed, and lapping over on each side, but extended at the points (see fig. 135). Branches spreading, flat, horizontal, irregularly scattered along the stem, slender, and of a deep brown colour. Branchlets flattened, short, slender, flexible, alternately two-rowed. Cones small, oval, tapering to both ends, nodding, and solitary at the extremities of the short branchlets.

1389. *Geography.*—This species of arbor vitæ is found more or less plentifully on the north-west coast of America, also on the mountains in California, at the latter place at an elevation of 5000 feet. It was introduced into Britain in 1854.

1390. *Description of tree.*—On its native sites this tree is said to attain heights of from 50 to upwards of 100 feet, with stems 2 to 5 feet in diameter, which are well clothed with long flexible branches, thickly set with branchlets. It is a thoroughly hardy species, and may be planted with every reasonable hope of success on most soils and situations on which our common hard-wooded trees succeed. It is a rapid-growing tree, and soon makes a beautiful, well-clothed, and middle-sized tree, and deserves a place in every park and pinetum where variety and beauty of foliage is an object. Its hardiness is its great recommendation, as it is adapted to make a sure growth even on much exposed parts where many of our newer coniferæ could not succeed.

Fig. 135.



1391. *Economic uses of timber.*—It is said that the timber of this species is very valuable, fine grained, and of a bright yellow colour.

1392. *Soil and situation.*—This species, as already inferred, is adapted to grow on any soil and situation on which our common hardwood trees succeed; but will, of course, attain its largest dimensions on a deep open-bottomed soil and sheltered site.

1393. *Propagation and culture.*—This species is propagated from seeds, and may also be propagated readily from cuttings.

1394. Specimens of this Thuja are plentiful in the country, from 20 to 30 feet in height.

SECTION LXXV.—THUJA OCCIDENTALIS, OR THE COMMON AMERICAN ARBOR VITÆ.

1395. *Specific character.*—Leaves very small, in opposite pairs, ovate-rhomboid, blunt-pointed, closely imbricated and flattened, thickly pressed along the branchlets, in four rows, and with an elevated gland on the back of the upper and under ones, which are the broadest, while the marginal ones lap over on both sides; those on the older branches are more distant, acute, extended at the points, decurrent, and of a dull yellowish green, strongly scented when bruised. Branches distant, horizontal, and irregularly scattered along the stem; smaller ones drooping, and twisted in various directions. Branchlets spread out laterally, numerous, two-edged, alternate, short, flattened, ramified, and covered with numerous small leaves of a bright shining green colour. Cones obovate, $\frac{1}{3}$ inch long, solitary, on short foot-stalks, covered with small scale-like leaves. Scales mostly six in number, oblong, spreading at the points, centre one truncate and divided to the base, each containing two seeds. Seeds very small, surmounted by a short wing.

1396. *Geography.*—This species is found in most parts of North America, from Canada south to the states of Virginia and Carolina, but by far most plentifully in Canada, where it occupies wet and swampy districts of the natural woods along with the American larch. It was introduced in 1596.

1397. *Description of tree.*—This species of arbor vitæ is well known in Britain, having been cultivated in the country for nearly three hundred years past. The size that this tree attains in its native country is generally understated by most writers, being set down at heights of from 40 to 50 feet, while in reality it attains, generally speaking, heights of from 70 to 90 feet, with proportionate stems. We have seen it ourselves in the American woods of the heights last stated, with stems from 2 to 4 feet in diameter, forming fine cone-headed trees, clothed with loose, open, spreading branches down to the ground. It is a very hardy tree, and useful for many purposes where shelter and ornament are required on exposed parts of the country. It is, however, as an ornamental tree, inferior to the *T. gigantea,* as it is seldom found so well clothed, nor is it so graceful in its habit.

1398. *Economic uses of timber.*—The timber of this species of arbor vitæ is of a very light texture, and is found to be of a very durable nature. In America it is used wherever it can be had for fencing purposes, and there we have seen palings made of it which had stood for thirty years, and when we examined the wood we found it still perfectly sound and without the least appearance of decay. It is also much used in building houses in America, as its lightness makes it well adapted for roofing purposes, and when so used it outlasts the pine.

1399. *Soil and situation.*—Although this tree will grow well on most soils and sites on which our common hard-wooded trees prosper, still, to grow it to a good useful size, it requires to be planted on a low-lying and sheltered situation, and on a deep, open, and cool-bottomed land. In its native habitats it is always found growing on the sides of flat-running streams, or on swamps, where there is ample moisture for its roots; but the best specimens of trees we generally found on sheltered sites by the sides of rivers, where its roots had plenty of moisture without that being stagnant.

1400. *Propagation and culture.*—This species, like the other one referred to, is easily propagated by seeds or by cuttings. The seeds should always be obtained from America, as the best plants are raised from seeds ripened in its native country.

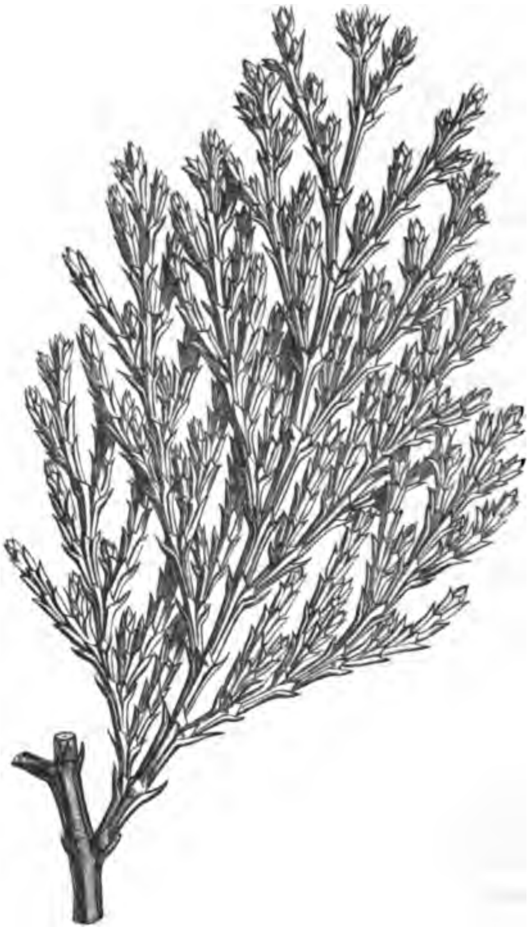
1401. This species is so common and so well known that it would be superfluous to give any particular instance of its growth in any particular locality. Suffice it to say, that on most places of any note there are specimens from 30 to 40 feet high.

SECTION LXXVI.—LIBOCEDRUS DECURRENS, OR THE DECURRENT-LEAVED ARBOR VITÆ.

1402. *Specific character.*—Leaves on the young plants awl-shaped, somewhat lanceolate, decurrent at the base, extending at the apex, and sharp-pointed, loosely imbricated in four rows, thickly set on the branchlets in opposite pairs, the outer pair or marginal ones being longest, and folded partially over the inner pair on both sides, giving the young shoots a jointed, trident-like appearance (see fig. 136). Leaves on the adult plants very small, scale formed, $\frac{1}{12}$ of an inch long, and $\frac{1}{24}$ of an inch wide, ovate, blunt-pointed, thick in texture, in close opposite pairs, rather distant along the branchlets, pale green, and shining, the marginal ones overlapping the sides, and having the appearance of being in three rows on each side. Branches rather erect, long, slender, and spreading laterally, with numerous smaller ones. Branchlets short, flattened, channelled along the sides, distantly jointed, many, short, and alternate. Cones erect, solitary on the ends of the upper branchlets, oblong, tapering to the points, 1 inch or more long, and ½ an inch wide near the base, and composed of two opposite pairs of scales, with a flat one down the middle, and of a pale olive brown colour.

1403. *Geography.*—This tree is found plentiful on the north-west coast of America, along the banks of the Columbia River, and on the mountains of Northern California. It is also found on the Sierra Nevada, and along the Sacramento River.

Fig. 136.



1404. *Description of tree.* — This forms a grand evergreen tree, growing from 50 to 140 feet high, and from 3 to 5 feet in diameter. It is quite hardy, a free grower, and is worthy of a place in every pinetum. It is often misnamed *Thuja gigantea.*

1405. *Economic uses of timber.*—This is what is called by the Californians "White Cedar." The timber is much used by them for many country purposes, and it is said to be of a durable character.

1406. *Soil and situation.*—Same as stated for the *Thuja gigantea.*

1407. *Propagation and culture.*—This tree is propagated from seeds chiefly, which of late years have been somewhat plentiful, and the plants are now comparatively cheap in consequence.

Fair specimens of it are plentiful in most pinetums in the country.

SECTION LXXVII.—THE JUNIPER (JUNIPERUS)—LINNÆAN SYSTEM, DIŒCIA MONADELPHIA.

1408. *Character of the genus.*—Male flowers axillary or terminal catkins; female ones, small axillary bud-like bodies, bracteated at the base. Fruit, a globular kind of berry, composed of a fleshy or fibrous juicy substance, covered with a glossy skin, more or less furnished externally with minute scales, and somewhat angular and naked at the apex. Seeds from one to five, but mostly three, in each fruit, obscurely three-cornered, and covered with a hard bony covering, having gland-bearing pits towards the base. Leaves simple, opposite or ternate, lanceolate or scale-formed, and either in extended whorls or closely imbricated in four rows (see fig. 137). Seed-leaves in twos. The junipers are all evergreen small trees or shrubs, found in the temperate and frigid regions of Europe, Asia, Africa, or America.

We shall refer only to one species of this family, as it is well known to be a hardy, useful, and ornamental tree in our climate, and may be said to be the tallest and hardiest of the genus, viz.:—

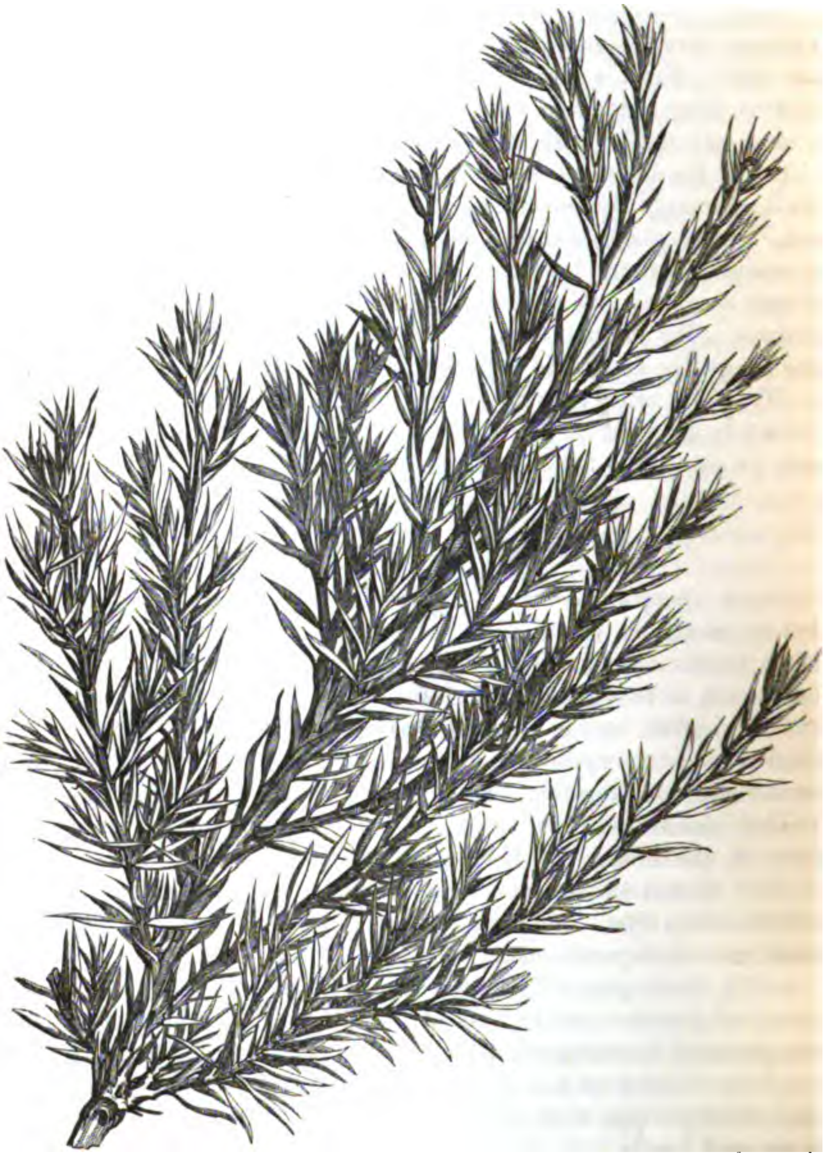
JUNIPERUS VIRGINIANA, or the Virginian Red Cedar.

1409. *Specific character.*—Leaves in twos, opposite, and 4-sided, but frequently in whorls of three on the young shoots; those on the adult plants closely imbricated, very small, and sharp-pointed, but afterwards as they get older become spread out at the points, glossy and light-green in the common form of the tree, but frequently becoming of a tawny-brown colour in winter. Branches horizontal, numerous, close together, and feathered to the ground. Branchlets 4-sided, slender, straight, spreading, and very numerous on the outer parts of the branches. Berries dark purple, small, ovate, smooth, or slightly warted on the surface, and covered with a white glaucous powder when ripe. Male and female flowers on the same plant, but sometimes on separate ones.

1410. *Geography.*—This species of juniper is found in the United States of America and in Canada on dry rocky hill-sides, but is not now plentiful in any particular district of these countries. We have ourselves found it on the sides of low hills in the valley of the Gateneau river growing with *Pinus resinosa*, and always found it on poor ridges and knolls, and never on low-lying parts of the country or on soils of a rich description. It was introduced into Britain in 1664.

1411. *Description of tree.*—This forms a very handsome tree, being always, when freely exposed, well clothed with branches and leaves from bottom to top. It does not, even in its native woods, ever attain the size of a large tree, as there we have never found it much above 45 or 50 feet high, with a stem of from 12 to 18 inches

Fig. 137.



diameter, and generally smaller. Indeed in this country the tree thrives as well as it does in its native woods. The leaves take very varied forms, some being needle-shaped, some lance-shaped, some oval-shaped, and some roundish, while both blunt and sharp pointed ones are common on the same branch; and sometimes they are found in pairs and sometimes in whorls, sometimes short and sometimes long, and of various colours or shades of green, from silvery green to a purplish green. The tree generally forms a beautiful upright habit, taking a conical shape, and its dense clothing of leaves affords excellent shelter to every other plant near it. It is in all respects perfectly hardy, and from this it is a general favourite on most old places, and is becoming so on many of modern date.

1412. *Economic uses of timber.*—This tree produces excellent timber, and it is much sought after in America for cabinet-making purposes, turnery, and other wood-work. It is chiefly with the wood of this tree that black-lead pencils are covered. In America the tree is best known by the name of red cedar. The smallness of the stem of this tree, however, renders it unsuitable for cultivation as a timber-producing one in this country, and it is only as a hardy ornamental tree that it is to be recommended.

1413. *Soil and situation.*—In Britain the tree grows best on a rather rich, porous, deep, and light loam, and lives longest on soil of a dry bottom. It is found to make the best growth, and attain the largest size, on a rather sheltered yet airy site.

1414. *Propagation and culture.*—This tree is propagated from seed. After the young plants come up they grow rapidly, and may be treated in the same way as the Scots pine—that is, they should be transplanted into nursery-rows when one year old; and as they are apt to lose fibrousness of root if left long undisturbed, they should be transplanted once in every two years till they are finally put out, which will depend upon the size they are wanted before planting them out on their final places. The seedlings of this tree sport a good deal, so that from the same seed-bed several varieties are usually obtained, different in leaves or in the habit of the branches.

1415. Good specimens of this tree are plentiful in all parts of the country, and therefore it is unnecessary to refer to them in any particular place.

SECTION LXXVIII.—CRYPTOMERIA—LINNÆAN SYSTEM, MONŒCIA MONADELPHIA.

1416. *Character of the genus.*—Male catkins numerous, somewhat oblong, and collected in clusters at the extremities of the branchlets; the female ones mostly solitary, or two or three together, without foot-stalks, spherical and terminal. Cones globular, woody, and either singly or in clusters. Scales wedge-shaped, numerous, loose, and with rough fringed edges. Seeds, from three to five under each scale, obovate or angularly depressed, and covered with a crustaceous tegument, prolonged on each side into a regular membrane, cut sloping at both extremities. Seed-leaves from two to four in number, but mostly in threes. Leaves alternate, in five rows, sickle-shaped, irregularly 4-sided, without any foot-stalks, but running downwards at the base, acute-pointed, spreading, and persistent (see fig. 138). There are two species in this genus, both large evergreen trees, found in the north of China and Japan. We shall refer to them both.

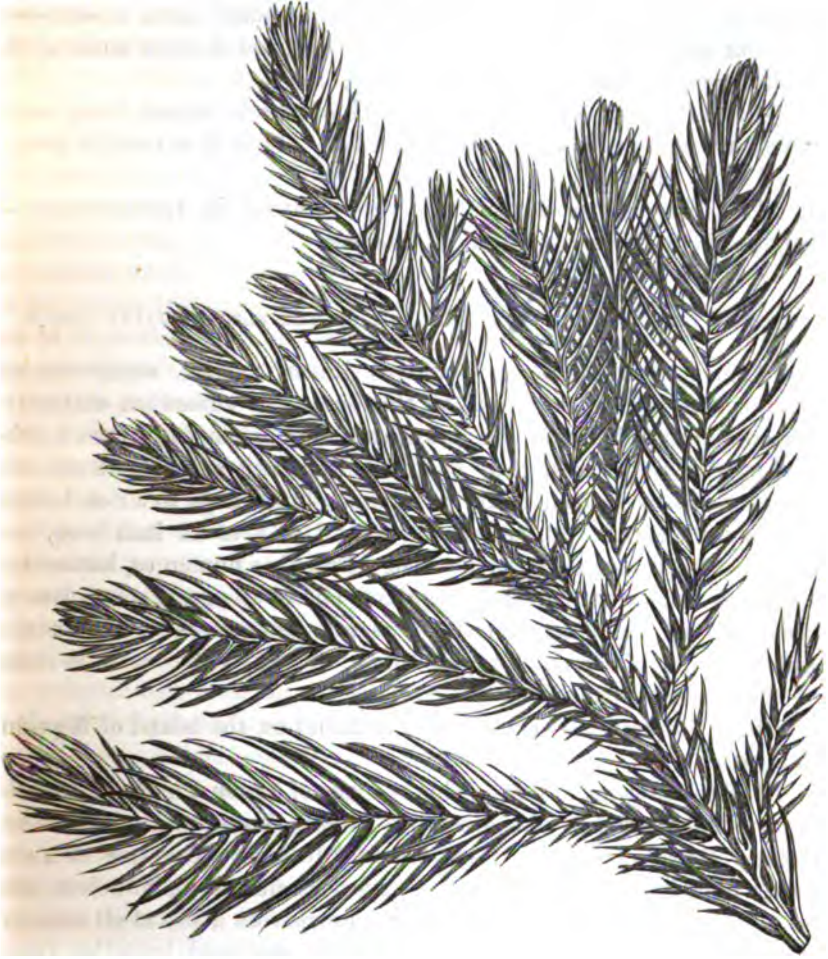
SECTION LXXIX.—CRYPTOMERIA JAPONICA, OR THE JAPAN CEDAR.

1417. *Specific character.*—Leaves five-rowed, without any foot-stalks, short-pointed, very close together, incurved or sickle-shaped, compressed on the sides, of a 4-sided, rhomboidal shape, running downwards on the under side, and with a sharp projecting mid-rib, from ¼ to ¾ inch in length, bright green, and quite smooth (see fig. 138). Branches erect or horizontal, spreading, lateral ones dividing alternately into numerous branchlets, thickly clothed with leaves. Cones about the size of a large cherry, mostly standing singly, but sometimes in clusters on the extremities of the branchlets, and without any foot-stalks, mostly erect, and of a globular shape, but not very compact or solid. Scales numerous, rather loose, of a dull brownish-red colour, and with rough fringed edges. Male flowers on the same tree, intermixed with the young cones, at the extremities of the branchlets, and of a small oval or oblong shape, in large loose clusters. Seeds ripen in September and October.

1418. *Geography.*—This tree is found plentifully about Shanghai and other northern parts of China in the form of groves and avenues, where it is said to have been introduced from Japan. Professor Thunberg states that it is found both spontaneous and planted on the mountains of Nagasaki and elsewhere on the southern mountainous districts of Japan, between an elevation of 500 and 1200 feet, generally growing in damp soils. It was first introduced into Britain by Fortune in 1844.

1419. *Description of tree.*—This is a most distinct conifer, forming a handsome, light, and graceful-looking tree, with a pyramidal head, having a highly ornamental effect among hardwood kinds on a lawn or park. In all the southern parts of the country it seems perfectly hardy, and grows luxuriantly; but in Scotland it requires the warmest sites and best soils to ripen its wood sufficiently to stand our winters. It prospers, however, even in the north of Scotland, showing that it is, generally speaking, hardy enough for the climate; and being so, it deserves a place in every park and pinetum where a suitable soil and site can be given it. The tree is said to grow from 60 to 100 feet high, with stems from 3 to 5 feet in diameter; and judging from the progress that many specimens have already made in this country, we are quite prepared to believe it will attain large dimensions in the more favourable parts of it.

Fig. 138.



1420. *Economic uses of timber.*—The wood of this tree seems soft, white, and brittle, and it is not likely ever to become useful as a timber-bearing tree in Britain. Its place is as an ornamental specimen in a park or lawn, and for this purpose it is well adapted.

1421. *Soil and situation.*—This conifer seems to grow best on a deep, light, open-bottomed soil, on a high-lying and sheltered situation. We have seen it on many diverse kinds of land, however; but the most vigorous-growing specimens were on a deep sandy loam, with rather a cool bottom, being near the edge of a watercourse. It does not stand winds, especially in spring; and generally when on an exposed site, at least in Scotland, its leaves get browned and discoloured. In all cases, therefore, the tree should have a sheltered site, but not a confined one, for if at all confined it loses much of its natural gracefulness and general beauty.

1422. *Propagation and culture.*—This tree is reared from seeds, which are ripe in September and October. It is also readily propagated from cuttings.

1423. Specimens of this tree are plentiful in the country, of heights from 30 to upwards of 40 feet.

SECTION LXXX.—CRYPTOMERIA ELEGANS, OR THE ELEGANT JAPAN CEDAR.

1424. *Specific character.*—Leaves linear, narrow, sickle-shaped, rigid, acute-pointed, decurrent at the base, and somewhat distinctly placed spirally all round the branchlets, and when fully grown bent backwards; they are slightly channelled on both sides, quite smooth, and of a cinerous green colour in summer, but change to a rich bronzy hue in the autumn and winter, and from ½ to ¾ of an inch long, and about half a line wide near the base. Branches numerous, horizontal, spreading, somewhat flat, and irregularly placed along the stem; lateral branches and branchlets alternate, curved downwards at the points, and in winter of a reddish-brown colour. Cones very similar to those of *Cryptomeria japonica.*

1425. *Geography.*—This species is found on the island of Nippon, in Japan.

1426. *Description of tree.*—This is a tree of a robust habit of growth, very much resembling the *Araucaria Cunninghamii*, and in its native country attaining heights from 60 to 100 feet. The tree is quite hardy in Britain, but like the other species referred to, it thrives best on a sheltered site; indeed it does not prosper on a site at all exposed to storms, but thrives well on parts well sheltered by taller trees. The specimens we have seen of this tree are all of a robust and branchy habit, forming beautiful objects among trees of a dark-green colour, as the generally rich bronze hue of the leaves contrasts pleasingly with that of other trees around them.

1427. *Economic uses of timber.*—Same as the other species.

1428. *Soil and situation.*—As already hinted, this tree will not prosper but on a sheltered site, and that on a low-lying part. As to soil it is not particular, if that is not too wet. It likes a cool-bottomed soil, but not a wet one.

1429. *Propagation and culture.*—Same as the other species.

1430. Fair specimens of this beautiful Cryptomeria are now plentiful in most pinetums in the country, but as we have had no returns in regard to it, we are not prepared to state the sizes it has attained.

SECTION LXXXI.—SEQUOIA GIGANTEA, OR THE MAMMOTH TREE—LINNÆAN SYSTEM, MONŒCIA MONADELPHIA.

1431. *Specific character.*—Leaves somewhat needle-shaped, spirally alternate, spreading, persistent, and of a light-green colour on the young plants; those on the adult trees scale-formed, closely inlaid, rounded on the back, and concave on the inner face; those on the branchlets much shorter, very close, and regularly imbricated; those on the larger branches longer, looser, decurrent at the base, and tapering to an acute point, but sometimes rather acute. Branches spread out horizontally, much divided, and furnished with numerous laterals. Branchlets cylindrical, frequently pendulous, and thickly covered with light-green glaucous foliage; cone-bearing ones slightly thickened, and entirely covered with scale-formed leaves, closely imbricated, the upper ones oval, and broadest at the base. Cones solitary on the ends of the branchlets, about 2 inches long, and fully 1 inch in diameter, ovate, blunt-ended, and slightly tapering towards both extremities. Scales in series, placed nearly at right angles upon the axis of the cone, stipitate, thickened, and enlarged from the point of insertion as far as the summit, which is depressed and wrinkled on the external face, and furnished with a small prickle in the centre of the little hollow. Seeds from three to five under each scale, but mostly five. Seed-leaves from three to six in number, but mostly in fours.

1432. *Geography.*—Like many of the trees of north-west America, the *Sequoia gigantea* seems to be confined to isolated patches. The first place where it was found was at the spot now generally known as "The Mammoth Tree Grove," near the head-waters of the Stanislaus and San Antonio rivers, in lat. 38° N., long. 120° 10′ W., and about 4590 feet above sea-level. The number of trees still standing there is about 200, of which 92 are of large size. The next locality discovered was the Mariposa Grove, about fifty miles south-east of the Mammoth Tree Grove. It is about 5000 feet above the level of the sea, and on the western slope of a high ridge of the Sierra Nevada. The trees here are spread along a lateral valley, on the flank of a main ridge, in two groves, about half a mile apart, known as the upper and lower grove. The number of trees of considerable size in these groves is about 600 in all. A third grove, containing about

500 trees, has beeen found in Fresno County, eight miles south-east of the Mariposa Grove. Another grove is reported by Mr Blake as having been discovered further south and east, upon the Kaweeab, or about fifty miles from Visalia. The *Sequoia gigantea* is said to have been introduced into Britain in 1853.

1433. *Description of tree.*—The *Sequoia gigantea* is certainly one of the largest known trees on the earth, if not the largest. The average dimensions of the tree, when full grown, are about 300 feet in height, and about 30 feet in diameter near the bottom; although it has been found about 400 feet high, and nearly 40 feet in diameter. The tree seems quite hardy in our climate, even in the north of Scotland, although the foliage sometimes becomes browned in a severe winter; yet, on the whole, it has proved itself fairly entitled to be classed as a hardy tree, and we think is destined to take a prominent place in our ornamental woods and plantations.

1434. *Economic uses of timber.*—The timber of this tree seems light, soft, and brittle, and therefore it is not as a timber-producing one that we are to cultivate it in this country, but only as an interesting ornamental one, and chiefly on account of its very rapid growth, and the large dimensions it attains compared with other trees.

1435. *Soil and situation.*—This tree seems to like a climate rather moist than dry, and therefore our British one is likely to suit it well, as has already been pretty well proved from the success of the specimens we have now luxuriating in all parts of the kingdom. It succeeds best, however, so far as our experience of the tree goes, on a dry and deep soil, and on rather an open situation, but not exposed. The best specimen we have seen stands on a dry sloping bank of very light soil, at Longleat, in Wiltshire. We think it is upwards of 40 feet high—we speak from memory—with a fine proportionate stem and top. The tree grows rapidly on most soils, however, if they are deep, open, and porous for the free escape of water. Indeed it will not prosper on land that is cold, retentive, or wet in the subsoil, nor does it prosper if confined among other trees, nor if exposed to high winds.

1436. *Propagation and culture.*—Seeds of this tree are now obtained in considerable quantities from time to time, and are therefore gradually becoming lower-priced than they were. Most nurserymen sow them in cold frames or in boxes in glass houses, and afterwards gradually expose them; but they succeed perfectly well when sown on a warm piece of ground in the open air, and ultimately make much better plants than those that are reared and nursed tenderly under glass during their first stages. In short, the seeds and young plants of this tree succeed perfectly when treated in the same way as the Scots pine; but those who do not wish to risk their seed in this way may sow it in a cold frame, giving the young plants, after they come up, full air all summer, and covering them during severe weather in winter. When the plants are one year old they should be planted out into nursery-lines, observing to give them plenty of room. They require to be transplanted every two years in order to make them fibrous in their roots, and prepare them for safe removal to their permanent sites. Cuttings of this tree root freely, and make very good plants.

1437. Specimens of this tree, of heights from 25 to nearly 40 feet, are common in many parts of the country.

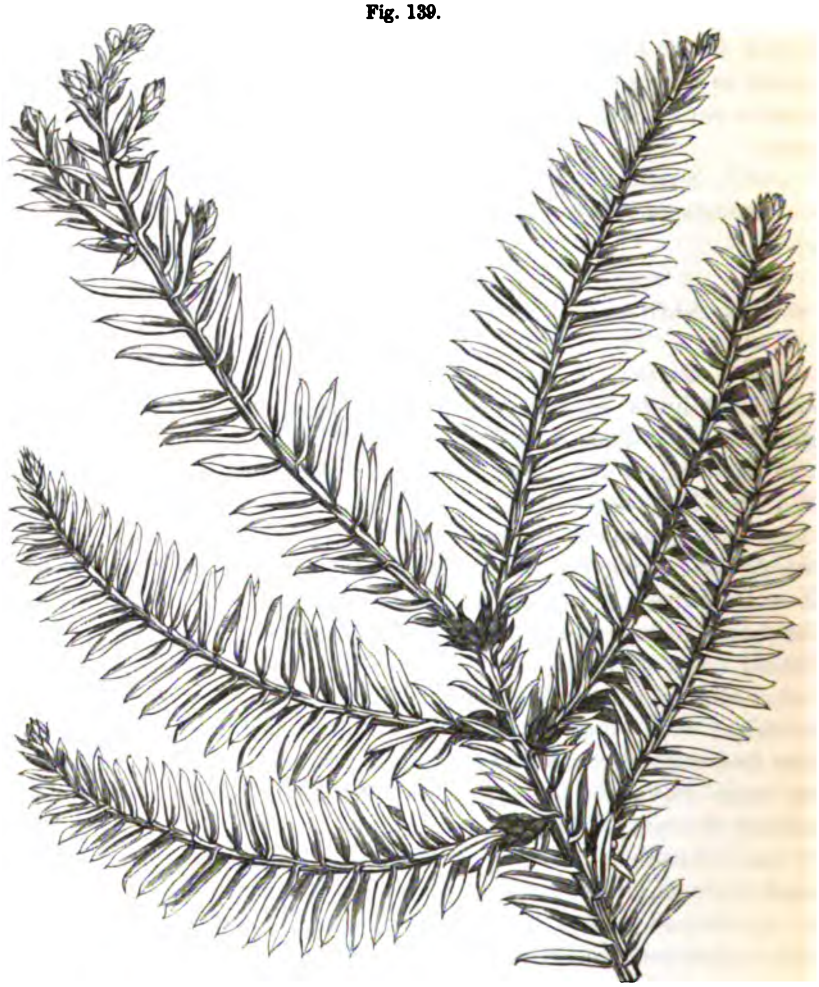
SECTION LXXXII.—SEQUOIA SEMPERVIRENS, OR THE CALIFORNIAN REDWOOD.

1438. *Specific character.*—Leaves on the lateral branches and branchlets linear, blunt-pointed, two-rowed, spread out, flat, alternate, straight, rarely falcate, leathery, persistent, shining, dark green, and smooth above, more or less glaucous, and channelled below; from ½ to 1 inch long, but much shorter and smaller near the extremities of the shoots; those on the principal branches and terminal points of the flower-bearing branchlets are very short, narrow, sharp-pointed, or scale-formed, somewhat imbricated or closely spiral, decurrent at the base, ribbed, and glaucous below, those on the leading shoots distant and very acute (see fig. 139). Branches spreading, horizontal, rather distant, irregularly scattered alternately along the stem, and furnished with numerous lateral ones in two rows, those nearest the base frequently bent downwards, while those towards the extremity are more elevated; branchlets very numerous, in two rows, and frequently drooping. Male flowers globular, solitary at the extremities of the branchlets, on slender foot-stalks, thickly covered with very small scale-like leaves. Cones solitary, terminal, somewhat globular or egg-shaped, rather blunt at the ends, and about 1 inch long. Scales numerous, wedge-shaped, from 16 to 20 in number, smallest near the base, transversely keeled, very much sunken in the middle, irregularly shaped, wrinkled on the summit, and furnished in the middle of the hollow centre with a stout, horn-shaped, blunt point, directed outwards. Seeds from 3 to 5 under each scale, variously shaped, and winged. Seed-leaves mostly in twos, but sometimes in threes, ovate-lanceolate, obtuse at the ends, slightly convex, and pale green on the under side, but of a much darker colour and somewhat glossy above.

1439. *Geography.*—This species of *Sequoia* was first discovered by Mr Menzies in 1796; afterwards by Douglas in 1836; and by the Russians (who first introduced it into Europe in the living state) in

1843; but since that time it has been found growing abundantly on the mountains of Santa Cruz, about sixty miles from Monterey, in California, where Mr Hartweg found that it averaged 200 feet in height, with trunks from 18 to 24 feet in circumference, quite straight and clear of branches to a height of 60 feet. One tree, which was called by the American settlers "the Giant of the Forest," measured 270 feet in height, and had a trunk 55 feet in circumference at 6 feet from the ground.

Fig. 139.



1440. *Description of tree.*—This tree seems quite hardy in the midland and southern counties, and also in favourable sites in the northern counties of England, but it has been found tender in most parts of Scotland. It is a rapid-growing tree on favourable soils and situations, and soon attains large dimensions, forming an upright-growing tree, with noble proportions, and having a very graceful and rather imposing appearance. It is quite a different-looking tree from its sister *gigantea*, but we think is a much more graceful one, its fine fir-looking foliage giving it a feathery and airy aspect. It is well worthy of a place in every park and pinetum in all parts of the country suited to it, but its comparative tenderness will prevent its becoming such a favourite in Britain as the *Sequoia gigantea* is.

1441. *Economic uses of timber.*—The timber of this species is not of a durable description, for although close-grained it is short-fibred and brittle.

1442. *Soil and situation.*—This species requires a deep, light, dry-bottomed soil, and a sheltered situation, to succeed well on, even in England. It is very irregular in starting into growth, and often makes its shoots late in the season, growing late into the autumn, and consequently it requires favourable soils and sites for maturing its young wood, so as to secure its not being injured in early winter. This tree should not have a rich soil, as that carries on its growths too late in the season, and causes it to make them of too succulent a character to resist our winters perfectly. Indeed it is chiefly to this cause that the tree has been found tender in the northern part of the island,—that is, its having been planted on too rich soils. Were it planted on rather poor but deep and porous land, it would succeed well on many places where it has succeeded only partially. In all cases, however, this tree requires a sheltered but airy site.

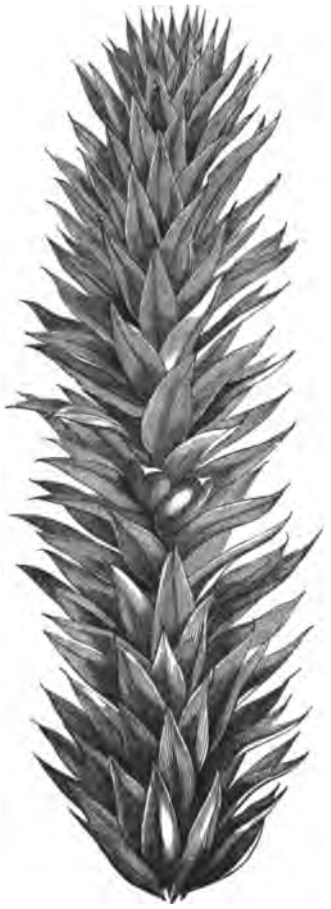
1443. *Propagation and culture.*—This species is raised from seed in frames, and after the young plants are up they are gradually exposed to the open air. They require protection for the first winter or two.

1444. Specimens, of heights from 30 to nearly 50 feet, are common in the country.

SECTION LXXXIII.—ARAUCARIA IMBRICATA, OR THE CHILI PINE—LINNÆAN SYSTEM, DIŒCIA MONADELPHIA.

1445. *Specific character.*—Leaves in whorls of from 7 to 8 in number, ovate-lanceolate, spirally placed, rigid, concave, straight, smooth, shining, deep green, very pungent, closely imbricated, and cartilaginous on the margin, entirely covering the stems, and remaining on for several years, ¾ to 1¾ inch long, very sharp-pointed, somewhat thickened at the base, but without any foot-stalk, and remaining on the shoots for years quite green, but getting more separated, closely pressing along the stem, and turning backwards as the tree increases in circumference (see fig. 140). Branches horizontal, somewhat ascending at the extremities, regularly divided laterally, in opposite pairs, and quite straight, from 5 to 7 in a whorl, diminishing in length as they ascend higher up the tree, until at the top they terminate in the leading shoot, and form a kind of pyramidal head: lateral branches long, straight, in opposite pairs, and regularly divided: branchlets cylindrical, thickly covered all over with leaves, rather slender, undivided, and mostly bent downwards; male and female on separate trees, male catkins ovate-cylindrical, in clusters of from 6 to 7 at the ends of the branches; females solitary and erect. Cones very large, globular, solitary, and erect on the ends of the top branches, from 6 to 8 inches broad, and from 6 to 7 inches long, of a dark-brown colour, with the scales regularly and closely imbricated, but when ripe quite deciduous, and soon dropping to pieces.

Fig. 140.



1446. *Geography.*—This tree forms vast forests in a part of the Andes inhabited by the Araucanians, a people who are said to pride themselves on their name, its signification being *frank and free.* It is found also in southern Chili, on the western slopes of the Andes, often reaching the snow-line, but never more than 2000 feet below it. It is also found in great abundance on the mountains of Caramavida and Naguelbuta in Chili, and in the neighbourhood of Conception. It was introduced in 1796.

1447. *Description of tree.*—This tree is said to grow to the height of 150 feet in its native country. Its appearance is altogether foreign, and quite different from any other we have had introduced into this country, hardy enough to stand and prosper in its climate. The stem is in all cases perfectly straight, and up to considerable age it is covered with its hard and sharp-pointed leaves from bottom to top, while the branches droop at first, and again ascend, giving the whole tree a formal and peculiar aspect. This remarkable tree is now too well known and appreciated to need any particular recommendation here. It is quite hardy in most parts of Britain, even in the north of Scotland, where it has been planted on a suitable soil and site. The tree is of somewhat slow growth, however, and is not likely ever to be found useful with us further than decorating our parks and lawns. It is a handsome and highly ornamental tree, however, and deserves a place in all dry and airy parks, as it presents a fine aspect when contrasted among other trees.

1448. *Economic uses of timber.*—The timber of this tree is said to be hard and of a very solid nature, but whether it may be so or not in this country is yet to be proved.

1449. *Soil and situation.*—This tree is known to grow well on most soils not wet in the bottom. To grow it well, however, it should have a soil free of all retentiveness, so that its roots can get down without interruption. The tree will not prosper on low-lying or damp sites, but on such generally sickens and becomes unhealthy at an early stage, as most others of our introduced kinds do. Besides a deep and dry soil, it likes a free and airy exposure. It does not prosper if exposed too much, however, as it does not stand well against high winds.

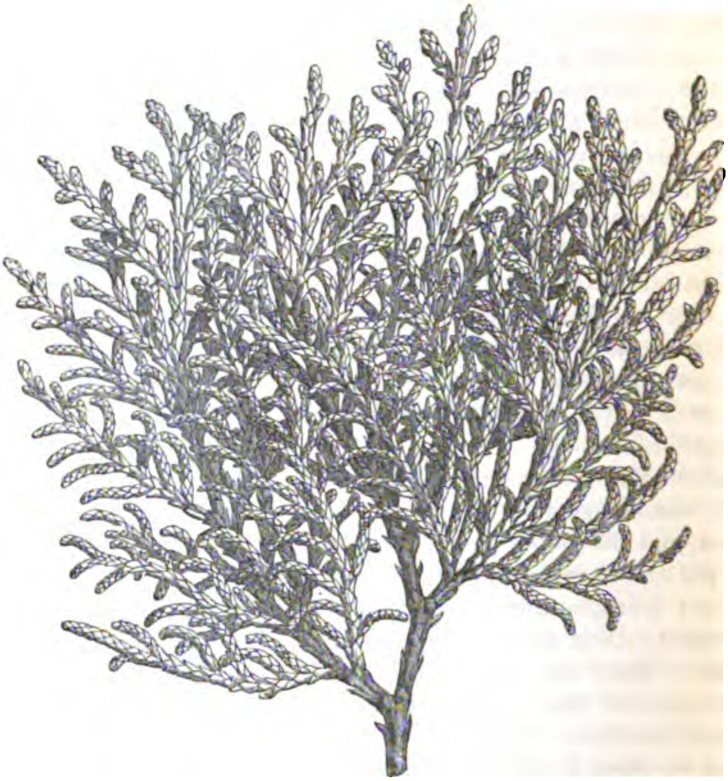
1450. *Propagation and culture.*—This tree is raised from imported seeds, which vegetate very readily. They are generally sown in cold frames, and the young plants are transplanted out after they are one year old and have been protected for the first winter. They require frequent transplanting in order to encourage fibrous roots for safe removal to their permanent sites.

1451. Many fine specimens of this Araucaria are now to be found in all parts of the country, from the south of England even to the north of Scotland. Trees of it are common, of heights ranging from 40 up to about 60 feet, and nearly all are healthy and still making progress.

SECTION LXXXIV.—BIOTA ORIENTALIS, OR THE CHINESE ARBOR VITÆ.

1452. *Specific character.*—Leaves on the adult plant very small, in four rows, ovate, rhomboid, acute-pointed, scale-like, imbricated, adpressed, decurrent, and furrowed along the base, the outer or marginal ones lapping over on both sides, the upper and lower ones flat, with the points thickened, glaucous, green, and shining when young; afterwards dull green when old and glandless (see fig. 141). Branches somewhat vertical and horizontal at first, but soon afterwards turn up at the ends, and finally become fastigiate with the stem. Branchlets disposed in two rows, densely crowded along the extremities of the branches, and placed sideways. Cones ovate-elliptic, 6-valved, solitary at the ends of the small branchlets, ½ an inch long, green when young, but light-brown when ripe, and composed of six scales, two being central, and four around the sides. Scales blunt, central ones truncate, with a short stout projecting point below the apex, each scale covering two naked, egg-shaped, somewhat angular, wingless seeds.

Fig. 141.



1453. *Geography.*—This evergreen tree is found in China and Japan, growing on rocky situations.

1454. *Description of tree.*—This forms a beautiful well-clothed tree all the year round; the densely furnished branchlets giving the whole plant such a compact look, as is not exhibited by any other conifer. It does not attain a large size, being seldom found much over 25 feet in height; but its compactness and deep green colour give it a character which contrasts pleasingly when found standing on the sides of roads in plantations, and it is for such situations that we here recommend it.

1455. *Economic uses of timber.*—This tree forms very little timber;

the plant taking more the character of a large bush than a timber tree.

1456. *Soil and situation.*—This conifer will grow well on any soil and site, if these are dry and not much exposed.

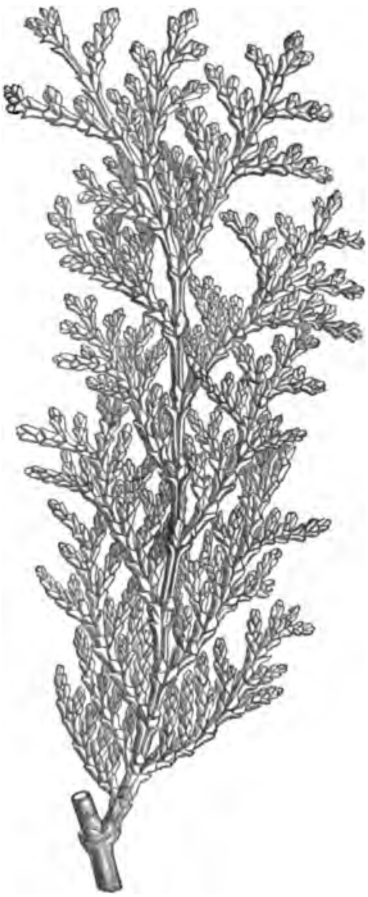
1457. *Propagation and culture.*—This tree is readily propagated from seeds, which should be sown in a cold frame, and when the plants are one year old they should be planted out into nursery-rows.

1458. Specimens from 20 to 25 feet high are plentiful in the country.

SECTION LXXXV.—RETINOSPORA OBTUSA, OR THE OBTUSE LEAVED JAPAN CYPRESS.

1459. *Specific character.*—Leaves mostly in whorls of 4, ovate-rhomboid, blunt, seldom pointed, decussate, all scale-formed, closely pressed along the branchlets, and adhering almost as far as the points, the lower part only being visible; those along the upper and under rows are ovate-rhomboid, obtuse, and seldom acute, while the side or lateral ones are keeled, and lap over at the edges, are somewhat pointed, and almost sickle-shaped; those on the younger plants are more open, longer, and remain on for several years (see fig. 142). Branches spreading, lateral ones in two rows, very dense, spreading out like a fan, and of a light shining green colour. Cones solitary, on the ends of the branchlets, globular, about the size of a small grape, with eight or ten scales in alternate opposite pairs.

Fig. 142.



1460. *Geography.*—This tree forms a large portion of the forests in the mountains on the Island of Nippon, in Japan, and is hardy in Britain.

1461. *Description of tree.*—It is a tall evergreen tree, growing from 70 to 100 feet high, with a stem from 3 to 5 feet in diameter, and has very much the habit of an arbor vitæ, from which, however, it is easily distinguished at first sight by the more spreading habit of the branches, and by these having a peculiar fan appearance. It forms a fine specimen in a pinetum.

1462. *Economic uses of timber.*—The timber of this tree is said to be white and fine-grained, of a compact texture, and durable.

1463. *Soil and situation.*—We have seen good specimens of this handsome tree growing healthily in most kinds of soil, but it requires a sheltered site to prosper well on.

1464. *Propagation and culture.*—Same as those stated in reference to *Biota orientalis.*

1465. Fair specimens of this tree are plentiful in the greater part of the pinetums of this country.

CHAPTER X.

SECTION I.—THE PLACES WHICH THE DIFFERENT KINDS OF TREES DESCRIBED IN CHAPTERS VIII. AND IX. SHOULD OCCUPY ON LANDED ESTATES.

1466. Having in Chapters VIII. and IX. briefly stated the peculiarities of each sort of forest-tree which is generally cultivated in our plantations for the sake of timber, as well as given our opinion in regard to such of the newer coniferæ as we consider hardy enough for growing to useful purposes in our climate, we now come to make a few general remarks in reference to the places which they should respectively occupy on landed estates.

Landed estates may, generally speaking, be classed under four heads — namely, 1st, those situated on the low-lying and level plains of the country; 2d, those on the table-lands of considerable elevation above the sea; 3d, those consisting of partly table-lands and partly hills; and, 4th, those situated wholly on the hilly and mountainous districts. With reference to the kinds of trees which should be used on each of these, we shall make a few brief remarks.

1467. On the first class of landed estates referred to—namely, those situated on the low-lying and level plains of the country—as they have the best soils and warmest climate, the oak, ash, elm, sycamore and other maple, with horse-chestnut and sweet-chestnut, beech, lime, poplar, willow, walnut, tulip-tree, and other hardwoods requiring good soils and sites, should be planted on them, together with larch, pine, fir, picea, and other coniferæ, as all of the trees described in the two sections referred to in the heading will succeed on them if the land is properly prepared, and the sites well chosen—all as described for each sort respectively.

1468. On the second class of estates referred to—viz., those on the table-lands at considerable elevation above the sea—all the different kinds of hardwood should be more sparingly planted than on estates situated on lower-lying districts, and all the conifers known as being perfectly hardy more abundantly. On estates of the class under notice, much more skill is necessary on the part of the forester to enable him to suit the trees to the different localities of the estate than is required in one that has to deal with the growing of trees on lower-lying estates, where the soil is more equal and the climate is very much better. On estates of this class there is generally a greater variety of soils and sites than obtains on estates situated on level plains, and in all cases of planting trees upon them, the place of the hard-wooded kinds should be on the heavier and least exposed portions of the lands, while that of the coniferous kinds is upon the lighter and most exposed parts. And in dealing with a subject of the kind in regard to planting, the hardiest kinds of both hardwoods and conifers should be selected and placed on the most exposed sites, and the less hardy kinds on the least exposed.

1469. With regard to the third class of estates named, or those consisting of partly table-lands and partly hills, the hard-wooded kind should be placed on suitable soils and sites on the lower-lying parts of the property, while coniferous kinds alone should be used on the hilly parts of it—observing always to keep the hardiest kinds of conifers on the poorest, highest-lying, and most exposed localities, and the more tender species on the less exposed sites, and chiefly along the lower slopes of the high grounds, and partly interspersed with the hard-wooded kinds.

1470. As to estates situated wholly on the hilly and mountainous districts of the country, our experience leads us to state that, with but few exceptional parts, such as hollows and ravines here and there, where a portion of the hardier kinds of hardwoods may be placed, coniferous trees alone should be planted, as in all cases on properties of the kind these are best adapted to both soil and climate, and therefore ultimately form the most profitable class of trees that can be grown on them.

1471. In all cases the hard-wooded kinds should be placed upon the most sheltered parts of any estate, and the hardier pines, firs, and piceas, &c., upon the high and exposed districts. This is only imitating the proceedings of nature in the same operation ; for in the natural disposition of trees over the surface of the earth, the pines, firs, piceas, and other cone-bearing trees, inhabit those cold, high-lying districts where the soil is variable and generally light, and comparatively poor; while the oak, ash, elm, &c., occupy the more temperate regions nearer the level of the sea, where the land is more equal and richer. The hardwood trees, to grow them well, require a heavier and a much richer soil than the coniferæ do, which suggests to us that, in dealing with the profitable planting of trees, the hard-wooded kinds should be placed in the heaviest and richest parts of the soil on any estate.

1472. With reference to the newer kinds of coniferæ described in

Chapter IX., it is enough to state here that the place of the greater part of them is in the park and woods in the neighbourhood of the proprietor's residence. There can be no doubt, however, that most of those described in this work will ere long be cultivated to a much greater extent among us than they are now, and some will even be embraced among our profitable timber-producing trees. In the meantime most of them are too scarce and high-priced to admit of extensive culture, and therefore their cultivation is only carried to a limited extent on any property.

1473. On estates lying along the sea-shore, no trees thrive so well as the *Pinus pinaster*, the Norway maple, the evergreen oak, the common yew, and the common beech. Upon estates having the sea as one of their boundaries, it is often difficult to get trees of any description to succeed to any considerable extent, even so as to make a moderate shelter; and it is in such situations that the trees named are found useful, especially the first three. Planted in such a situation, they do not, of course, rise up so as to make valuable timber themselves; yet, as they grow very bushy, they form an excellent shelter for trees inland; and by the shelter obtained from them, the more valuable trees behind succeed, which is the end in view in planting them.

SECTION II.—THE PINETUMS OF BRITAIN, AND WHAT THEY HAVE DONE FOR THE INTERESTS OF THE ARBORICULTURE OF THE COUNTRY, WITH SOME SUGGESTIONS IN RESPECT TO FUTURE PINETUMS.

1474. Pinetums mean, generally speaking, districts of land set apart on estates for the experimental cultivation of the newer sorts of coniferous trees.

1475. Within the last forty years many such have been made; and there are now very few landed properties of any considerable extent on which there is not one, less or more in extent, according to the taste of the proprietor and capabilities of the place.

1476. These pinetums are, for the most part, found occupying sites in the home parks of their proprietors, or in the immediate neighbourhoods of their mansions, thus combining ornamental effect with the experimental cultivation of the subjects; and in this way we have the sylva of every country to which our commerce has reached spread over our island from south to north and from east to west, there being now few estates in Britain which cannot show fair specimens of recently-introduced trees interspersed with the kinds that have been long in cultivation in our plantations, thus forming new and very varied and distinct features in the landscape of our country. From these very praiseworthy exertions of our landed proprietors in all parts of the country, we are now in possession of an amount of knowledge and experience in respect to the hardihood of the newer coniferæ which is very valuable and highly important to the interests of the arboriculture of the country, and gives confidence to those whose place it is directly to deal with it to achieve still greater results in the future.

1477. From what we have just said, it is to be inferred that great advantages have been gained to the arboriculture of Britain by the pinetums existing in the country; and this is in all respects the truth of the case, although the advantages gained must only be taken in the limited sense, that they are proofs taken from the most favourable side of the question—that is, from pinetums existing in favourably-situated spots on the respective parts of the country. The existing pinetums, so far as they go, have been of very great advantage to all concerned, and have proved much to us that we had no knowledge of before they were established so extensively over the different parts in which they are found in the country. Still, it must be admitted that in order to grow the newer-introduced coniferæ in such a way as most certainly to prove the hardihood of the subjects for being planted in our usual forest-grounds, and their fitness for becoming profitable as crops of timber, they must be treated in the same way as we treat our common forest-trees, and be planted on the same sites and soils along with them; for until we carry out a scheme of this kind on estates on all parts of the country, and at the different elevations on which planting is usually undertaken on them, our experience of the newer coniferæ must be limited to their growth on the most sheltered sites and best soils of the respective parts of the country on which they are found.

1478. Any proprietor wishing to grow the newer coniferæ with a distinct view to ascertain not only the general hardihood of the species he may have in view to plant, but also to prove their suitableness to grow as timber in a close plantation, as well as their adaptation to ornamental purposes, and also to prove how far the different species are affected by the difference of elevation and of aspect, should plant them on all the various soils, aspects, and elevations he has available on his estate, observing, of course, to suit the different species to their natural requirements, as nearly as possible, on the different soils and sites embraced.

1479. In carrying out this mode of proceeding in regard to the cultivation of the newer coniferæ, part of them could be planted in small masses, each kind by itself, while part of them might be planted intermixed among themselves; but the greater portion of them should certainly be planted intermixed with larch as nurses, or, it might be, on some particularly exposed parts, with some species of hardy pine as nurses.

1480. When the nurses had attained some size, and it was found necessary to thin, this could be done in all sorts of ways: on some parts severely, in order to admit of the specimens developing their branches thoroughly, so as to show their natural habit; on others the nurses might be more moderately removed, in order to prove the effects of a considerable degree of shelter and confinement on their habit and rate of growth; while on others they might be left somewhat crowded, in order to prove whether they might make tall and straight trees for timber,—and these different degrees of thinning might be applied on all the different species without reserve. Of course, in carrying out an experiment of this kind, it would not be necessary to plant the whole of an enclosure with the newer coniferæ in the way proposed, but only portions of it here and there on the different altitudes, soils, and sites embraced.

1481. We are aware that a good few enterprising landed proprietors have already begun this mode of dealing with the newer coniferæ in the younger plantations on their estates, and in time we hope to be able to refer to the success the different species have made in the different parts of the country. There is no doubt that many others will follow the example, and it is with this view that we refer to the subject here.

1482. The undernoted kinds, as they are well known to be hardy, and suited to become less or more valuable as timber, should be especially planted out in our woods and plantations in the way referred to—namely: *Pinus*—Austriaca, resinosa, Laricio, ponderosa, Benthamiana, Monticola. *Abies*—Douglasii, Menziesii, orientalis. *Picea*—Cephalonica, nobilis, Nordmanniana, pinsapo. *Cedrus*—Deodara, Atlantica. *Cupressus*—Lawsoniana, Nutkaensis. *Thuja* gigantea and *Sequoia* gigantea—the latter tree more for its grand effect than for the value of its timber.

SECTION III.—AS TO HOW FAR THE VARIOUS SORTS OF CONIFERÆ INTRODUCED ARE LIKELY TO BECOME USEFUL IN THE CLIMATE OF GREAT BRITAIN.

1483. We have, in Chapter IX., stated our opinion at length in regard to such of the coniferous trees as we have found, from some years' experience, hardy enough for the climate of Great Britain; but as there are many other species that have been introduced into this country to which we have not referred at all, we shall say a few words on the subject of the newer species generally.

1484. Of late years a great number of different new coniferæ have been introduced into this country, chiefly from the mountainous regions of Asia and America, and especially from the Himalayas, Japan, California, Mexico, and the north-west of North America, some of which have been proved hardy enough to stand our climate, while others are evidently too tender to bear the winter, even in the most sheltered parts of our open grounds, without protection.

1485. For the last thirty-five years we have paid great attention to the subject of the newer sorts of coniferæ, and the result of our experience on it is our recommendation of those which we have found quite hardy, as detailed in Chapter IX.—of course keeping out of view altogether those sorts which have been long introduced, and which we have for many years cultivated for their timber, and are embraced with the newer sorts in the chapter named.

1486. We are aware that, besides the sorts which we have recommended, there are others which at present may be said to be hardy enough to grow on favourable sites in various parts of the southern portion of the country, but as we wish to test such sorts still further than has been done in the south, by seeing how they succeed when planted on more elevated and northern sites, we postpone giving an opinion on them till they shall have been longer in the country, and subjected to the test of further experience. In the meantime, however, we may state, in a general way, that there are, in our opinion, many more kinds which will be found hardy enough to grow with us, and even become valuable, both as timber and ornamental trees, provided that they shall be properly dealt with in regard to soil, and site, and mode of culture.

1487. No branch of arboriculture has received so much attention, or has been more popular, than that of the cultivation of the newer coniferæ; and this is to be attributed not so much to their value in a timber point of view, as to our admiration of them as ornamental specimens. But be this as it may, we may here assert, as our opinion as to how far the newer coniferæ are likely to become useful in the climate of Great Britain, that, for profitable planting in the various soils, altitudes, and different degrees of climate in our country, no species of trees are better adapted than some of those of the great coniferous family; for from it we can select trees which are thoroughly hardy, producing excellent timber, growing rapidly and to very great dimensions, and which are withal not particular as to soils and situations, and by no means, if properly propagated and cultivated, subject to prematurity or early decay. Therefore we conclude this section by saying that, in our opinion, a very large proportion of the newer coniferæ are to become highly useful in this country, both on account of their timber and the ornamental effect they are calculated to produce. Where, for instance, could we have anything so admirable in point of majestic form and gracefulness as the *Abies Douglasii* or *Picea nobilis*, or anything in vegetation so gigantic as the *Sequoia gigantea?* These, and many, very many, others of the great cone-bearing tribe, are destined to take the place of our old acquaintances in the tree way, and to bring about a new aspect in our landscape, harmonising in infinite variety and utility with our old broad-leaved deciduous kinds, and with our esteemed larch and Scots pine.

SECTION IV.—SHOULD THE INTRODUCED CONIFERÆ BE REARED FROM HOME-GROWN SEEDS, OR FROM SEEDS PROCURED FROM TREES GROWING IN THEIR NATIVE COUNTRY?

1488. This is a question of the greatest importance to the cultivator, and we shall therefore say a few words in answer to it. The difficulty of procuring the seeds of many of the newer coniferæ from their native countries has led British cultivators to resort to various modes of propagating them, such as *grafting, layering*, and by *cuttings*. But the plants reared by all of these artificial modes have been found very inferior as compared with those that have been reared in the natural way from the seeds sent home from the native countries of the different species. In time, however, many of the earlier introduced species bore seeds, and from those seeds plants have been reared; but, generally speaking, the plants that have been reared from those home-grown seeds have been found not nearly so strong and healthy as plants grown from seeds brought from their native country. We shall take the *Picea nobilis* as an example to the point.

1489. It must have been observed by all cultivators of the newer coniferæ that, in raising plants of *Picea nobilis* from home-grown seed, a very large proportion of the seedlings become diseased at a very early stage of their growth. This disease shows itself by the leaves first decaying at the points, and gradually becoming dead altogether; the leaves begin to wither, and this withering spreads till the whole plant has a rusty appearance, and the disease is generally known among cultivators by the name of "the rust." It seems to arise from a languid circulation of the juices of the plant, caused, it would seem, by a weakness in its vitality, perhaps originating in imperfect impregnation. Be this as it may, this weakness of the young plants, and consequent early decay, has hitherto, so far as our knowledge of the subject extends, been confined only to plants produced from home-grown seeds, and has not been found in respect to plants raised from seeds brought from the native country of the tree. This disease is, without doubt, caused by constitutional weakness, arising from imperfect impregnation in our climate. As already stated, the plants raised from home-grown seed, and which escape the disease referred to, have been found of a weakly constitution as compared with plants raised from foreign seed; so that it is but reasonable to infer that seedlings from these weakly-constitutioned plants, if they ever have vitality enough to enable them to bear seed, must inherit the weakly constitution of their parents, and so become still more and more weakly and diseased; and this brings us to give the direct answer to the question put as the heading of this section, which is: All the introduced coniferæ should be reared from seeds procured from trees growing in the native country of each respectively; as unless we attend to their propagation in this way, we must gradually have them of so diseased and deteriorated a character, as to be comparatively worthless.

1490. Those who wish to propagate plants of the newer coniferæ from home-grown seed should, at all events, attend to assist impregnation in the female flowers at the proper period, as, doubtless, although the plants that might be afterwards reared from seeds made more perfect in this way might not inherit such a degree of vitality and vigorous constitution as others raised from seeds brought from the native countries, still they might be improved as compared with plants raised from home-grown seeds that had had no assistance. We throw out this merely as a hint for cultivators to turn over in their minds, and to make use of and experiment on according to such opportunities as they may have.

1491. Another point which naturally falls in here for consideration is that of procuring the seeds of the different species from trees growing on such localities in their native regions as will insure the plants being perfectly hardy in this country when reared in it. We all know that seeds gathered from trees growing in a warmer climate than our own produce plants too tender to succeed in it without protection, and that only seeds taken from trees growing in an equally cold climate with our own can be expected to produce plants hardy enough to succeed satisfactorily in our variable climate. In getting the seeds of the different species from their native regions, then, it should never be lost sight of that much of the success in cultivating the plants from them depends upon whether they may have been gathered from trees growing in low-lying and therefore comparatively warm localities, or from high-lying and therefore colder parts. In sending out seed-collectors, therefore, none should be intrusted with such an important piece of business but trustworthy parties, who will look to the interests of arboriculture at home, and will be certain to make it a point to collect seeds only from trees growing on the high and cold regions of the various parts they are found in, as unless this be attended to, disappointment must follow in many of the species turning out less hardy than we expected.

1492. There can be no reasonable doubt that if we procured seeds of the various species only from trees growing on the high and cold regions of the mountains they are found on, we should find the greater part of them quite hardy enough for growing even on our hills in the north of Scotland along with our native pine, and should in consequence have little trouble in cultivating them compared with what we have now; but, unfortunately, when irresponsible parties gather the seeds of the respective kinds in the native districts of the trees, they very naturally collect them from such trees as are easiest got to —that is, on the lower parts of the mountains, where the climate is of course warm compared with what it is higher up; and the result is, that we find the plants reared from such seed much tenderer than we expected them to be. Therefore we repeat that in collecting the seeds of the different coniferæ from their native regions, they should in all cases be taken from trees growing on the highest-lying and coldest parts of the country they are found on, as in such a case we are sure to have a hardy and healthy race of plants when grown here —in all probability with sufficient vitality in their constitutions to enable them to produce as perfect a progeny as if they were natives of our country; while, on the contrary, if the seeds be gathered from trees on the lower and warmer parts of the mountains they are found on, the plants will be found tender, and, in our climate, weak in their productive energies.

1493. We are aware that it is commonly supposed that, in length of time, plants may be rendered hardy enough to endure a colder climate than they were produced in by nature. This is what is called acclimatisation, and those who hold this opinion say that by slow degrees tender plants may become acclimatised to cold climates. This view, however, is in all respects inconsistent with facts. Each species of plant has been constituted by nature to bear a certain range of temperature, and it has been found impossible to extend this range to any considerable degree. We can always, it is true, succeed in growing a tree by placing it in a warmer climate than it had previously existed in, but we cannot harden the same tree to thrive in one to any considerable degree colder.

SECTION V.—THE RECENTLY-INTRODUCED CONIFERÆ SHOULD BE PLANTED ON LAND OF RATHER A POOR DESCRIPTION, AND NEVER ON THAT OF A RICH CHARACTER.

1494. A great mistake is often made in the cultivation of the introduced coniferæ by planting them on rich lands, whereby the plants overgrow themselves, and at the end of the year are found with growths of so succulent a nature that the climate cannot ripen them sufficiently to resist the action of the frosts of our winters. There can be no doubt whatever that a large proportion of the failures that have taken place in respect to the growing of certain species on certain places in this country is to be attributed to this cause—namely, their having been planted in soils so rich as to have induced too luxuriant a growth to admit of our autumn sun maturing it.

1495. We are well aware that in the case of many of our common hardwood trees, which, in moderate conditions of soil, ripen their growths perfectly, when they are planted on a very rich description of land, in which their growth is excited to an unusual degree, have the points of their shoots much injured by the succeeding winter's frosts. Now, if this take place in our climate in respect to even our common oak and sycamore when they are found on very rich lands, what can we expect in regard to the newer coniferæ when placed in similar circumstances?

1496. For our own part, we have every reason to believe, from facts that we have observed in respect to the growth of the introduced coniferæ in various soils and sites on different parts of the country, that much of the success of one cultivator over another lies in his proper discrimination as to suiting the soil to the requirements of the plants in our variable climate; and one of the principal points to attend to in successfully dealing with such of the species as are known to be less hardy than some others, is to plant them on land of rather a poor description, and *never on that of a rich character.* In our climate the great risk is, in the case of plants growing on rich soils, not so much the degree of frost we usually have, as its coming early in the beginning of winter, when the plants cannot resist it, in consequence of being, as it were, full of sap. From this, then, the attention of the cultivator should be directed to bringing his plants into as *dry* and *matured* a state of wood as possible at the beginning of winter. In order to effect this, the land should be thoroughly drained in the first place, which will carry off all superfluous moisture from it, and prevent the plant drawing too much moisture from it into its system. In the second place, the soil should, if not naturally somewhat poor, be rendered so by an intermixture of sand or gravel, so as to prevent the plant making too luxuriant growths, and thus enable it to ripen its wood perfectly before the frosts of winter set in upon it.

1497. If these points were judiciously attended to in the cultivation of the introduced coniferæ, many of the species which are now considered rather tender for successful cultivation in the climate of many places of Britain, would doubtless be found hardy enough under ordinary circumstances; but so long as cultivators will continue to prepare rich soils for the newer cone-bearing trees in our climate, they must expect to have disappointments in their endeavours to rear them. In land of rather a poor description, every kind of tree we grow escapes the risk of being stimulated into succulent growth, and is insured of ripening its shoots so early as to escape having them injured by autumn frosts, while on rich lands the case is quite the opposite.

SECTION VI.—ALL THE NEWER CONIFEROUS TREES REQUIRE A PURE AIR TO SUCCEED WELL IN, WITH A RATHER HIGH-LYING, AIRY, AND DRY SITUATION, AND SHOULD NEVER BE PLANTED ON LOW-LYING AND HUMID HOLLOWS.

1498. Coniferous trees being chiefly natives of the hilly and mountainous regions of the globe, where the air is always found of a purer and more rarefied nature than it is on the lower-lying plains, they do not grow healthy if at all exposed to the impurities contained in the air in the neighbourhood of our towns and cities. Much of the unhealthiness of many of the newer coniferæ, as they are found in some places, is to be attributed to the state of air they have been reared up in, in the first stage of their growth; for we hold that no coniferous plants that have been reared for the first five or six years of their existence in nurseries situated within the unhealthy influence of the smoke of towns can possibly have so sound a constitution as those that have been reared in the purer air of a country nursery. Therefore, in cultivating the newer coniferæ, perfectly healthy and robust specimens are not to be expected unless the plants have been reared in a pure state of air from the very first opening of their seed-leaves, and have been planted out on permanent sites under the same favourable conditions. But besides purity of air, a somewhat high-lying, airy, and dry site is equally necessary to their healthy and perfect development; as in conditions of an opposite character the plants are out of their natural position, and consequently do not obtain that robust healthiness which they are fitted to do in an upland site not too much exposed, but where there is a free and open exposure.

1499. In low-lying and humid hollows the ground may often appear in a perfectly sound and healthy condition, and even well adapted for the growth of the trees, and in such parts they have generally more heat than those on higher situations, and consequently make larger growths for a time; but in the greater number of cases plants so situated will show symptoms of sickening and disease at an early stage, and very often die suddenly. This is caused by the roots of the plants drawing more moisture into their vessels than the leaves are able to elaborate into proper woody matter, thus giving rise to plethora, and sudden death in consequence; for it must be kept in view that the coniferous trees are not what is generally termed *gross feeders*, their leaves not being constructed for assimilating large quantities of food, like those of many of our hard-wooded trees.

1500. In the rearing of the newer coniferous trees, then, the cultivator should, if he wished to be really successful in this branch of arboriculture, avoid planting them in low-lying and humid hollows, and attend to plant them on sites rather high-lying than otherwise, where they will have plenty of healthy air without undue exposure—and by all means on land made perfectly dry by drainage if it is not naturally so.

SECTION VII.—CONIFERS THAT ARE DISPOSED TO COME INTO GROWTH AS EARLY IN THE SEASON AS TO HAVE THEIR YOUNG SHOOTS INJURED BY LATE FROSTS CAN HAVE THIS NATURAL TENDENCY TO EARLY GROWTH RETARDED.

1501. It is well known among all cultivators of the newer coniferæ that some of them, and especially of the Picea tribe, have a natural tendency to come so early into growth in the climate of Britain that the young shoots very frequently are injured by late frosts in the beginning of the summer; and it is generally recommended in respect to such species as have this tendency, that they should be planted on western and northern exposures, in order that their growth may not be excited so early on such *back-lying sites* as it is when they are planted on sites having eastern or southern exposures. This recommendation is perfectly sound and consistent so far as it goes, as plants occupying northern and western sites are always later in starting to grow than the same kinds are when found occupying opposite sites; but then every proprietor has it not in his power to choose northern and western sites on which to plant the specimens he wishes to rear. There are many places having eastern sites, and no other; while there are perhaps more having southern sites alone—and in these cases the recommendations stated as to northern and western sites cannot be applied, at least to any important extent or bearing; and therefore, to those who have not northern and western sites to plant on, we give the following modes of proceeding with a view to enable them to retard the natural tendency of such of the newer coniferæ as they find to come so early into growth as to have their young shoots injured by late frosts.

1502. In the case of species having the tendency referred to, a good plan is to cut their roots all round in spring with a spade; this has nearly the same effect to check their early growth as would be the case were they transplanted. We have often adopted this plan ourselves with Piceas and other species, and found the effect in all respects satisfactory, the cutting of the roots checking the flow of the sap, and in consequence the expanding of the buds, for two or three weeks, and thus preventing the young shoots coming out so early as to be injured by late frosts. This cutting of the roots should be performed just when the buds show a disposition to open, this depending upon the lateness or earliness of the season, but generally in the early part of April. In performing this operation on the plants, if they are small, say not over 2 feet high, the roots may be cut all round about 9 or 10 inches out from the bottom of the stem, using the spade in the same way as if it was intended to lift the plant with a ball. After the roots have been thus cut all round, a little loose earth should be spread on the open cut left by the spade, in order to prevent drought getting to the roots, and this should receive a slight tramping with the foot to make the two sides of the cut adhere. If the plants are above 2 feet and under 3 feet high, the roots may be cut at about 12 inches out from the stem; if above 3 feet and under 5, say 14 or 15 inches out; if above 5 feet and under 7, say at 18 inches out; and if above 7 feet and under 10, they may be cut at about 22 inches out. Above the latter height there is little or no danger of the shoots being injured by frost; for if the plants are on at all suitable soils and sites, there is no risk of injury to them from frost, that being only the case while the plants are small. This cutting of the roots does not injure the health of the subjects, but merely retards their growth for two or three weeks in each season, which is the object in view, in order to prevent injury to the shoots. After the cutting of the roots has been left off, the plants will be found to make extraordinary rapid progress upwards, this being brought about by the great mass of fibrous roots they have made in consequence of having been cut in from time to time.

1503. Another plan which may be adopted is to make openings in any young plantation of some six or eight years' standing, where the trees, say larch or pine, are from 8 to 10 feet high, and to plant the specimens of whatever kinds may be thought desirable in the openings, taking care to remove entirely all roots of the trees that stood in the openings made by trenching the spots before planting the specimens in them. These openings may be made at any distance apart, according to the object in view, but each opening should not be made larger than may be found sufficient for the specimens having full air and light without being in any way encumbered by the surrounding taller trees. Specimens of the newer coniferæ, say Picea, planted in openings made among older trees in this way, seldom or never receive any injury from frost—that is to say, if the soil be dry and the site airy—as the shades of the taller trees keep the rays of the sun from them, and prevent their coming early into growth; while at the same time, when frosty winds do occur they are protected from them, and generally grow up more healthily and satisfactorily than trees planted on the open ground without any such protection. Of course the taller nurses are thinned away as the others need space.

1504. Young trees planted on dry and airy sites are very much less subject to be injured by frosts in their young shoots than the same kinds found growing in low-lying, damp, and confined sites; therefore, in planting the newer coniferæ, care should be always had to see that the character of the situation is not of the latter description, as if so, considerable difficulty and trouble will be experienced in order to grow healthy specimens of many of the species; and where this has been overlooked in the planting of a pinetum, the foregoing recommendations will be found useful in improving the circumstances of the case. We are the more confident as regards this from having seen much benefit arise from the adopting of these simple remedies where cases had seemed hopeless and unimprovable before they were put into operation.

SECTION VIII.—WHERE SOME OF THE BEST COLLECTIONS OF THE NEWER CONIFERÆ ARE TO BE SEEN IN GREAT BRITAIN AND IRELAND.

1505. As it may be interesting to many foresters to know where some of the best collections of the newer coniferæ are to be seen in the country, we give the following list of places where they may find them. We shall give the names of these in their alphabetical order, followed by the post-town and name of the proprietor in each case.

Altyre, ...	Forres, . .	Sir W. G. Cumming, Bart.
Ballindalloch Castle, . .	Ballindalloch, .	Sir G. Macpherson Grant, Bart.
Ballyfin, ...	Mountrath, . .	Sir Charles Coot, Bart.
Ballymacool, . . .	Letterkenny, .	J. R. Boyd, Esq.
Bedgebury Park, . .	Cranbrook, . .	Rt. Hon. A. J. Beresford Hope.
Bicton, ...	Budleigh Salterton,	Lady Rolle.
Bodorgan, ...	Anglesey, . .	Sir George Meyrick, Bart.
Bury Hill, . . .	Dorking, . .	R. Barclay, Esq.
Carclew, ...	Penryn, . .	Colonel Tremayne.
Carlowrie, ...	Kirkliston, . .	R. Hutchison, Esq.
Castle Kennedy, . .	Stranraer, . .	Earl of Stair.
Castle Martyr, . . .	Castle Martyr, .	Earl of Shannon.
Cave Hill, . . .	Belfast, . .	Miss Whitlaw.
Chatsworth, . . .	Chesterfield, . .	Duke of Devonshire.

Clandeboye,	Belfast,	Earl of Dufferin.
Coolattin Park,	Carnew,	Earl Fitzwilliam.
Craigo,	Montrose,	T. M'Pherson Grant, Esq.
Curraghmore,	Portlaw,	Marquis of Waterford.
Dalvey,	Forres,	Norman M'Leod, Esq.
Dalwick,	Stobo,	Sir James Naesmyth.
Darnaway,	Forres,	Earl of Moray.
Derby Arboretum,	Derby.	
Dropmore,	Maidenhead,	Hon. G. M. Fortescue.
Drumbanagher,	Loughbrickland,	M. C. Close, Esq.
Drumlanrig Castle,	Thornhill,	Duke of Buccleuch.
Dublin Botanic Gardens.		
Durris,	Stonehaven,	W. T. MacTear, Esq.
Eaton Hall,	Chester,	Duke of Westminster.
Edinburgh Botanic Garden.		
Elvaston Castle,	Derby,	Earl of Harrington.
Enville Hall,	Stourbridge,	Earl of Stamford.
Essendon Place,	Essendon,	Baron Dimsdale.
Fingask,	Errol,	Sir P. M. Threipland, Bart.
Flitwich House,	Ampthill,	Mrs Brooks.
Florence Court,	Enniskillen,	Earl of Enniskillen.
Haddo House,	Methlick,	Earl of Aberdeen.
Hafodunos,	Abergele,	H. R. Sandbach, Esq.
Hatfield Park,	Hatfield,	Marquis of Salisbury.
Highnam Court,	Gloucester,	T. Gambier Parry, Esq.
Hopetoun House,	Queensferry,	Earl of Hopetoun.
Keillor and Balgowan,	Methven,	Mr Thompson.
Keir,	Dunblane,	Sir J. M. Stirling-Maxwell, Bart.
Kew Gardens,	Isleworth.	
Kilkenny Castle,	Kilkenny,	Marquis of Ormond.
Kinmel Park,	Abergele,	H. R. Hughes, Esq.
Linton Park,	Staplehurst,	Viscountess Holmesdale.
Longleat,	Warminster,	Marquis of Bath.
Mentmore,	Aylesbury,	Earl of Rosebery.
Methven Castle,	Perth,	Wm. Smythe, Esq.
Moncrieff House,	Bridge of Earn,	Sir R. Moncrieff, Bart.
Mount Shannon,	Limerick,	Lady L. Fitzgibbon.
Murthly Castle,	Dunkeld,	Sir A. B. D. Stewart, Bart.
Penryn Castle,	Bangor,	Lord Penryn.
Poles,	Ware,	Robert Hanbury, Esq.
Powerscourt,	Enniskerry,	Viscount Powerscourt.
Raith,	Kirkcaldy,	Mrs M. Ferguson.
Riccarton,	Edinburgh,	Sir J. H. Gibson-Craig, Bart.
Rockingham,	Boyle,	Col. E. R. King Harman.
Rossie Priory,	Inchture,	Lord Kinnaird.
Scone Palace,	Perth,	Earl of Mansfield.
Sion House,	Isleworth,	Duke of Northumberland.
Wentworth,	Rotherham,	Earl Fitzwilliam.
Weston Park,	Shifnal,	Earl of Bradford.
Whitfield Hall,	Hexham,	Mrs Ord.
Wilton House,	Salisbury,	Earl of Pembroke.
Woburn Abbey,	Woburn,	Duke of Bedford.
Woodstock,	Inistioge,	Lady Louisa Tighe.

SECTION IX.—IN REARING THE NEWER CONIFERÆ FROM SEEDS, THE SEED-BEDS SHOULD BE SHADED FROM THE DIRECT RAYS OF THE SUN TILL THE YOUNG PLANTS APPEAR AND HAVE GAINED STRENGTH.

1506. Those who cultivate the newer coniferæ from seeds are aware that the drying effects of the early summer's sun on these often prevent the greater part of them from vegetating, and therefore use means to protect them from the direct rays of the sun till the young plants have appeared above ground, and gained sufficient strength to draw nourishment from it. Various means are resorted to for the purpose of shading the surface of the seed-beds from the direct rays of the sun—such as stretching common garden mats or thin cloth over them, and sometimes the branches of evergreen; but all these are objectionable, because both mats and thin cloth throw too much shade on the surface of the beds, and cause the young plants to come up weakly, while evergreen branches soon wither under the sun's heat, and in a short time become almost useless for the purpose. We have ourselves tried all the ways referred to, but have found them insufficient, and now adopt the following mode, which we have found to answer the purpose satisfactorily. We place boards, 9 inches broad and ¾ inch thick, on their edges, in a regular line, along both sides of each of the beds, supporting them in their places by strong pins driven into the ground at the parts they meet. These boards all fixed, and forming, as it were, a box of each bed, we next place thin laths on them, right across the beds, each 3 inches apart from the other, and have these nailed at each end on the upper edges of the boards. These laths should be about 3 inches broad only, and cut to suit the breadth of the beds, and in this way the openings and laths will be of equal breadth, and afford sufficient light and shade to the surface of the beds, and insure the vegetation of the seeds, so as to produce healthy and strong plants. By adopting this mode of shading the seed-beds, the frames, as they may be called, can be allowed to remain on them till the plants are pretty strong, and have taken a good root-hold, when they should be gradually removed by taking off, first, each alternate lath, and, after a while, the frames in all.

CHAPTER XI.

SECTION I.—DISTRIBUTION OF YOUNG TREES SO AS TO SUIT DIFFERENT SITUATIONS IN A NEW PLANTATION.

1507. Next to the thorough draining of the soil, nothing is of more importance, in order to insure the future welfare of any young plantation, than the proper adaptation of the different sorts of trees to the various soils and situations therein. This is a point in arboriculture which has been too little attended to by planters in general; and the not attending to it is in a great measure the reason that we at the present day see very many of our plantations in an unsatisfactory state. We have often regretted very much to see coniferous trees standing in an unhealthy and dying state, where, if any of the hardwood trees had been planted, they would undoubtedly have proved both useful and ornamental; and, again, as often have we seen stunted-looking hardwood trees striving for existence, where, if firs or pines had been planted instead, all would have been well. Upon a little reflection, it must appear evident to every inquiring man interested in the welfare of plantations, that a forester, in order to be one profitably, must be perfectly acquainted with the natural habits, constitution, and peculiarities of every tree that he attempts to cultivate; for if he is not so, the ultimate result of his work must in a great measure be left to chance. Gardeners have been assisted by the advice of many able and scientific men, who have written much for their instruction; while the forester has had comparatively little written for his information. A gardener cultivates several thousand of distinct species of plants; yet he is generally able to adapt each species to that sort of soil which is found to be best suited to its nature. The gardener, in cultivating a *heath*, for instance, gives it a light, sharp, mossy soil, and a cool dry situation; he does so because he knows that the heath, in its native country, is an inhabitant of a light dry soil, and hilly or mountainous situation: and so on with every other plant he cultivates. Now, the principal thing to be observed here is, that the gardener who cultivates his plants with the most success is he who can by his art give his plants most nearly that soil and situation which is found to be their condition in a state of nature; which is just the point that the forester ought to attend to also.

1508. Foresters, knowing that trees in the natural forest develop themselves to the greatest magnitude there, ought to make themselves aware of the particular circumstances which induce or assist that full development; and upon knowing the peculiar circumstances attending the full development of each species in the natural state, they ought to make their practice agree therewith; which is the only way that any man can arrive at perfection as a forester.

1509. Having in Chapters VIII. and IX. entered into some detail upon the habits and peculiarities of the various species of the trees we cultivate, it will be of importance to take a view of their geographical distribution. Such a statement we know to be necessary in order to a right understanding of the distribution of young trees in new plantations of any considerable extent.

1510. Every forester ought to look upon the estate, of the woodlands on which he may have the management, with the eye of a geographer. He ought to consider it as a continent in itself: each plantation may be looked upon as a separate kingdom, according to its altitude; and each of these, again, may, in the mind of the forester, be divided into provinces, according to aspect or altitude, and planted with those trees which are known from nature's own rules to be the best adapted for it.

1511. All our forest-trees of known worth are natives of the temperate or frigid zones. The temperate zones are inhabited by the various species of our hardwood trees, and in the extremities of the temperate zones, and under those of the frigid, we find the different species of the pine, fir, birch, and alder. The trees natural to each of these zones are not, however, always bounded by a certain degree of latitude; for the temperature of any given place does not always depend upon its distance from the equator. Various causes have a tendency to modify the heat both of the earth and the air—such as large extent of continent, nearness to the sea, and locality as regards the east or west sides of continents or islands. The height of any given place above the nearest sea-coast also greatly affects its temperature. Elevated situations are in all cases colder than others under the same latitude near the level of the sea; and the higher that we ascend upon any mountain or hill, the lower the temperature becomes, till at last we find its summit covered with snow. This may occur upon any part of the surface of the globe, provided the mountain rises high enough; and from this we see that a change of climate does not always depend upon the degree of latitude we may be in, much depending upon the elevation of the ground; consequently, in all these places a change of vegetation takes place. For example, about the base of the Pyrenees the vine and the oak grow luxuriantly; on going a little way up those mountains, these disappear altogether, but the pine, the birch, and the alder are found. On proceeding still farther up, the pines disappear also, and nothing is found in the shape of vegetation but dwarfish willows, heath, and mosses. And the same thing is observable in our own country, although not to the same extent. In all the lowland counties of Scotland, the oak, ash, elm, and sycamore thrive well, while upon the high mountainous districts of the northern counties they will not succeed. At this height the fir and the pine tribes are found in excellent state; while there is an altitude beyond which the fir and pine will not grow to useful size, and in their place dwarfish birch, heath, and moss are to be seen. There is one point relative to the altitude of a place which is worthy of being noticed here, and that is—supposing two situations, each 1000 feet above the level of the sea: if the one situation is the top of a hill, and the other a flat table-land of some extent, the situation upon the top of the hill will be much colder than the other, although both are of the same height; and supposing the soil to be of equal quality upon both, trees would succeed much better on the flat table-land than they would do upon the top of the hill, although the one is as high as the other,—all this pointing out that the intelligent forester must take into consideration not only the altitude of a situation before planting upon it, but also the very shape of the surface of the ground, in order to succeed; or if he do not, he will be certain to commit errors in his profession. And as we have already said that much of the forester's success depends upon properly adapting the trees in a plantation to the different situations in it, the above observations are necessary to be kept in view.

1512. The healthy growth of trees is also much affected by the peculiar locality of the part of the country in which they grow. For instance, in Norway, on the coast of the Atlantic Ocean, the oak is found growing in lat. 63°, while in the eastern parts of Europe, on the confines of Asia, it will not grow in lat. 57°; this showing that the west of the continent of Europe is much milder than it is inland, and also that the sea-coast is much more temperate than a country inland upon the same latitude. Again, relative to the oak: in Asiatic Russia, upon the river Argoun, in the same latitude as London, the oak is said scarcely to exist, from the extreme coldness of the country; proving the mildness of a maritime country such as Britain, and its better adaptation for growing trees, as compared with the extensive regions on the north of the Asiatic continent, and that the west of Europe is much milder than the continent of Asia under the same latitude.

1513. It is generally remarked that the west side of an island or continent is milder than its east side, but this does not always hold good in regard to our own island, for it is well known that the east coast of Britain is warmer than the west. The west coast may indeed be reckoned more equal in temperature throughout the year, but our principal corn-growing counties are situated upon the east side of the island—from the Lothians in Scotland to Kent in England. The east side of Ireland is much warmer than the west of Scotland which is opposite to it; and this is occasioned by the storms from the Atlantic beating upon the west side of Scotland, while the east of Ireland is sheltered from them. Upon the east of Ireland, about Donaghadee, the most tender of our forest-trees grow with great luxuriance; while upon the west coast of Scotland, about Portpatrick, which is only 18 miles distant from the latter place in Ireland, not a forest-tree of any consequence can be made to grow for a considerable distance back from the sea-shore,—which proves that even in places of the same altitude, in planting trees upon them, the kinds to be chosen must also depend upon *aspect* and exposure to storm from prevailing winds.

1514. With regard to the pine and fir tribes: In Norway and Lapland the Scots pine is said to attain the height of 60 feet in lat. 70°; and Von Buch says, that in Tornea, at the head of the Gulf of Bothnia, the birches are *magnificent.* Now, let us compare this with the northern parts of Britain. In the Orkney Islands, about lat. 60°, scarcely anything having the form of a tree is to be met with but the hazel, which bears the winds of the Atlantic better than either the Scots pine or the spruce: this is occasioned by the extraordinary rush of storm passing along the Atlantic among the northern islands, which prevents trees from growing to any useful size. On the other hand, it is very remarkable that the spruce fir in Sweden is found eight degrees farther north than the hazel, and this occurs on the coast of the Baltic.

1515. In Scotland we have extensive natural forests of the Scots pine but none of the spruce fir, which at once points out to us that the spruce fir in our country is not nearly so hardy as the Scots pine; and in order to grow it to advantage, it must be planted in a much more sheltered situation than the Scots pine requires. Now this is the more remarkable when we take into notice that there are forests of the spruce fir in Norway as far north as lat. 67°, which is much colder than the climate of Scotland; but this can be accounted for by the extreme humidity of the climate.

1516. Again, in Norway and Sweden it is said that the larch is not found at all in a state of nature—just as the spruce fir is not found with us; yet we find the larch and spruce in Siberia, much farther north than either the Scots pine or the birch, which is a remarkable characteristic of the country in the north of the Russian empire, and points out the larch as being more hardy than even the Scots pine in inland districts.

1517. In Asiatic Russia the tree found farthest north upon the Arctic Ocean is the larch; next to it, in progressing southwards, is the spruce fir; next the Scots pine; and, still progressing south, we meet successively the lime, the ash, the oak, the beech, the elm, and the poplar.

Now, if we apply the above observations as to the natural distribution of our common forest-trees over the continent of Europe and Asia, we shall at once see that the same natural laws, to a great extent, guide their development in our island—at least, in so far as our experience leads us to form a correct judgment in the case of our artificial forests; with, of course, different modifications, according to the aspect of different parts of the country upon which they are planted. In some high-lying inland parts of Britain, the larch is known to be more hardy than the Scots pine; while, again, in the northern parts, bordering more upon the sea, the Scots pine is found more hardy than the larch. The spruce, again, in Britain is more tender than either the Scots pine or the larch; but in this it is not so much affected by the degree of cold as by the situation it may be planted in; for example, it will bear more cold in a flat part of the country than it could do upon a high part, where it would be exposed to winds and sudden storms; and that is exactly its nature in the countries on the Continent in which it is found growing naturally. The oak is also found to succeed much better in a moderately level part of the country than when exposed to sudden and frequent storms of wind; it is, like the spruce fir, not so much hurt by any degree of cold as by exposure to high winds: therefore, in general, we are led to remark that the more equal and level any part of a country is, the farther north will the spruce fir and hardwood trees be found to succeed; and the more mountainous any part of a country is, just in the same proportion will these trees be checked in extending northward. At the same time, however, in making calculations of this nature, it must be kept in view that the air upon any mountain 1000 feet above the level of the sea will, in the neighbourhood of the sea, be much more temperate than a height of 1000 feet upon a mountain far inland and away from the influence of the sea.

1518. Now, what we desire to deduce from these observations relative to the geographical distribution of our forest-trees is, that a forester, in planting any part of an estate, must keep all these peculiarities of the different kinds of trees in view, and plant that sort of tree which is found to answer according to *altitude* or *aspect.* As we have already said, the forester should view the estate he may have to manage as a continent in miniature, and manage all his wood operations accordingly,—planting firs and pines upon all the highest parts, and hardwood in all the lower parts: and not only should he view the whole estate in this light; he should view any single plantation he may have to make in the light of a kingdom, and plant the most prominent parts with pines, and all the lower parts having a good soil with the more valuable sorts of hardwood. As this is according to nature, it not only gives the best possible effect to the plantation as an object, but it adds also considerably to the healthy growth of the whole as a plantation; for when heights are planted with firs, the hardwood under them are sheltered by them; and from being sheltered they grow quicker, and come sooner to answer the end in view.

SECTION II.—PLANTING GENERALLY CONSIDERED.

1519. Planting being one of the most important operations of the forester, every point bearing upon it, and having a tendency to secure its success, should be carefully and maturely considered before engaging in it, otherwise failure is as likely to attend the operation as success.

1520. Every judicious and intelligent forester, before he commences to plant any enclosure of considerable extent, should sit down and calculate how he is to get on with it under all or any circumstances that are likely to occur, so that he may never be taken unawares whatever may come in his way. During the planting season this can always be managed by having other works besides planting ready to go on with if the weather should prove unfavourable. We ourselves always endeavour to have draining and road operations and thinning on hand, so that at any time we can turn the men to these if we find the weather unfit for planting; and we have the whole thing so arranged that at an hour or two's notice we can muster the whole to plant when the weather takes a favourable turn.

1521. In short, the planting season is and ought to be to the forester what the harvest season is to the farmer—a time of anxiety and looking out on the weather. At least, it is so with ourselves, and we think it should be so with every forester anxious to do his duty to his employer and to himself. The results of inattention in this respect are often very great. We have seen an enclosure of

300 acres have to be replanted to a large extent from no other cause than that of doing the work hurriedly, the forester wishing to make it appear that he could do it cheaply. But let it be kept in mind that work done hurriedly is generally only half done.

SECTION III.—SEASON OF THE YEAR BEST ADAPTED FOR PLANTING OPERATIONS.

1522. Many practical planters have laid down that the months of March and April are the only proper months or season of the year adapted for planting operations. For our own part, we have planted extensively at all times between the months of October and April, both included, while the weather was open and suitable, and have had equal success from planting in all the different months. We may, however, say that we always prefer the months of November and December for the planting of hardwood, and those of February, March, and April for the planting of the fir and pine tribes. If the ground intended to be planted be naturally dry, we put in both hardwood and firs in the months of October, November, and December; but if naturally wet, and the drains only recently made, we delay planting such ground till the spring months.

1523. Where planting operations are not carried on extensively, it may be an easy matter to delay till a certain time in the year, as the private opinion or convenience of the party intrusted with the work may suggest to him; but where 300 or 400 acres are intended to be laid down in wood in one season, it is always found necessary to take advantage of the whole season from the middle of October till April, whenever the weather will permit, in order to have the work all done before the growth of the plants begins, which is generally about the middle of April. Those who advocate planting in the spring months only, say, where planting operations are to be executed upon an extensive scale, "put on the greater number of men, and have the work done in the shorter time." But those who advise to put on a great number of men in order to have the planting of a piece of ground quickly accomplished, cannot have had much experience in the results of such operations as performed at different times and under different circumstances.

1524. Every experienced planter who has had occasion to employ a considerable number of men, in order to get through his work as fast as possible, is aware of the difficulty there is in getting a large number of labourers, from any neighbourhood, properly qualified to conduct the operation well, and as it ought to be done. Common country labourers are seldom acquainted with planting operations, and require at least a few weeks' practice before they can be safely trusted; therefore it is, that when a number of inexperienced men are brought together to plant, the work is always badly done, and consequently is seldom attended with satisfactory success in the end. In planting extensively, our method has always been, to prolong the season of operations, and with a few experienced men to do the work in a proper manner; and by so doing, we have generally been very successful.

1525. In reading the above assertion, many may be inclined to say, that if the weather were to prove unfavourable, it would be impossible to get through an extensive piece of planting with a few men in one season—and at first sight there appears, indeed, some reason in this objection; but we answer, that very much depends upon the proper management of the work in hand. In planting extensively, with a few good hands, we do not generally begin at one end or side of the plantation, and make good all the ground as the work proceeds, as is the custom with many planters who employ a great number of men at once. In almost every piece of ground laid out for an extensive new plantation, there is generally a variety of soils and situations in it; and of this variety of soils and situations we always take advantage thus:—When the weather is fine and open, we set the men to plant upon the most exposed sides or parts of the ground; and when the weather is cold or wet, we set them to plant upon the most sheltered parts; while in the case of frost coming on, we always reserve other works for this, such as thinning, making new roads, and various others, which can be done during frost, and is still carrying on the work, and at the same time keeping the workmen in employment. In short, by conducting planting operations in the manner above referred to, ten good experienced men will do far more work in four months than twenty inexperienced ones in two months; and, what is of more importance, the work by the few hands will be much better done, and prove far more satisfactory in the end. A very good common-sense rule is to plant dry ground with an open bottom in autumn, either with hardwoods, pines, or firs, and to plant ground naturally cold in the subsoil in spring; also to plant dry, light, and open-bottomed ground in wet weather, and ground naturally cold in the subsoil in dry weather. Any planter who will go to work upon these principles, will find the happy results arising therefrom.

SECTION IV.—DIFFERENT METHODS OF PLANTING YOUNG FOREST-TREES IN GREAT BRITAIN.

1526. In the planting of young forest-trees, two different methods are in practice among foresters: the first is that of planting in *pits*;

and the second, that of planting in *notches*, either with the common spade or the planting mattock. The method of planting in *pits* should be employed for all hardwood trees, for two years' transplanted larch and pine, and for three years' transplanted spruce firs. These pits are made with the common spade, at various distances, of from 4 to 16 feet, as the case may be; that is, if the whole of the plantation intended to be done is to be planted with hardwood and two years' transplanted firs or pine, then the whole ground will require to be pitted to the distance required, but observing to make the pits for the hardwood larger than those intended for the firs or pine. In order to do the work properly, all the pits for the hardwood should be made first, say 15 inches on the side of the square, and 14 inches deep; then, having these pits made at the distances, say, of 16 feet from pit to pit, make those for the firs and pine 9 inches on the side of the square, and 10 inches deep, and just as close one to another as may be considered sufficient for the nature of the ground—say 4 feet over all. If, after having the pits made for hardwood upon a piece of ground, it is found advisable to plant up with one year's transplanted pine, then no more pits will require to be made there, for it is not necessary to be at the expense of making pits for any pine which are under two years' transplanted.

1527. In the making of such pits as are above described, we generally let the work by contract. We cause the contractor to cut off the upper turf as thinly as possible, and lay it on one side of the intended pit; and in taking out the soil in the act of making the pit, he lays it upon the opposite side, which comes to be of great advantage in the act of planting. Where the soil is hard in the pit, the pick must be used to open it up to the desired depth. We have generally got pits made for hardwood, to the dimensions already named, for 1s. 6d. per hundred, where there are no large stones or roots of old trees—and where these do exist, at from 2s. to 2s. 6d. per hundred; and those for pine for 1s. per hundred in the former case, and for 1s. 6d. in the latter.

1528. In the case of planting a piece of ground among old roots, the remains of former trees, the pits should be made at least six months previous to their being used. By having the soil in the pits a few months exposed to the influence of the atmosphere, it becomes much more healthy and congenial to the roots of the young plants.

1529. The manner of planting the young trees in those pits must be regulated according to the situation of the ground to be planted; that is, if the situation be a low sheltered one, we plant a tree in the centre of each pit, and, cutting the turf which comes off the surface of the pit exactly into two halves with the spade, we make them fit closely upon the young tree, with the grass side uppermost. But if the situation be an exposed one, then we plant a tree in one of the corners of each pit; and by so doing it is kept firm in its place by finding support against the sides of the pit—which method should always be practised when the trees are apt to be blown about by winds and storms. In planting trees in such pits, great care is necessary to see that they be made perfectly firm in the new soil of the pit. But in making the trees firm in the pits, no tramping or beating with the feet should be allowed until the whole of the earth is put in; for if the planter begin to beat the earth upon the roots of the young tree while they are only half covered with soil, he is sure to do them injury. Knowing the evil of this from experience, we never allow a man to beat the earth about the roots of a young tree until he has it all into the pit, when a good firm tramping with the feet is necessary in order to keep the plant properly in its place until its roots take hold of the soil. After the earth has been all put into the pit and made firm, the turf should be put over the whole as closely as possible, and made firm, in order to keep out the drought.

1530. It is, however, only necessary to plant in pits those trees which are of pretty large size, such as hardwoods, larch, firs, and pines, two years transplanted and upwards. Trees under that age and size, having smaller roots, only require to be planted in the natural surface soil, which is generally free and open to the roots of all small plants.

1531. The method of planting termed *notching* or slitting is done with the common spade or planting mattock, and is so well understood by all planters that it would be superfluous to enlarge upon it here. It is the practice most commonly in use for the planting of all small trees, such as two years' seedlings, or one year's transplanted pine or larch. The great point to attend to in this system of planting is to see that the cut or notch be properly closed about the young plant after it is inserted, which should be done by the planter using the heel of his shoe in beating the cut all quite close again. The system of notching in trees by the planting mattock is done upon the same principle as that by the spade, and is generally practised upon a thin hard surface, where the spade could not be used conveniently.

SECTION V.—DIFFERENT METHODS OF PLANTING YOUNG FOREST-TREES IN THE UNITED STATES OF AMERICA, AND IN THE BRITISH COLONIES.

1532. In the Prairie States of the Union, farmers generally plant hedges and shelter-belts of willow trees in the following way:—The cuttings are generally made from the branches of trees, and from 3 to 6 feet in length, choosing pieces from 2 to 3 inches diameter. The cuttings made and in readiness for planting, a trench of 15 inches in depth is made by the plough or spade, as the case may require, and into this the cuttings are placed, in a regular line, and about 12 inches apart, and this done, the soil is returned into the trench, and made firm about the cuttings. One row of such cuttings is considered sufficient for making a hedge fence, but if a shelter belt is wanted, then three, four, or five lines of them are planted parallel to each other, and from 4 to 6 feet apart, line from line, as the proprietor may consider necessary for his purpose. Such hedges and belts grow up rapidly, and in a few years attain the height of 20 feet, producing abundance of wood for fuel, and a great degree of shelter to the crops, and shade to the live stock on the lands in their neighbourhoods.

1533. In many parts of the States crops of young trees are raised by sowing the seeds on the land they are to occupy permanently. In doing this the land is previously ploughed and harrowed, so as to secure its being in a good condition for the reception of the seeds. The different kinds of seeds are sown on this prepared land in lines separately: that is, say, ash in one line, maple in the second, elm in the third, and oak and chestnut in the fourth and fifth, and so on, as the case may be. Previous to sowing the seeds the land is marked out into squares by the plough, as if Indian corn were to be sown on it, and at the intersections of the furrows the seeds are sown, four to six at one spot. The distance apart may be 3, 4, 5, or 6 feet, according to the views of the farmer. The land thus sown with tree seeds is kept clean, and sometimes agricultural crops are raised on it between the lines of trees, for two or three years, and till the young trees have attained some size. When the plants have all come up, they are thinned to one plant at each spot, and vacancies are made up with the young plants taken out, as the state of the crop may require, to make it all good. In such cases the young trees grow so rapidly that at the end of six or seven years from the time of sowing—here the trees are supposed to stand 3 feet apart—every alternate row is removed, and at the end of ten years every alternate tree in each row left has to be removed, and at the end of twelve years from sowing, the stems of the young trees generally stand from 6 to 8 inches diameter near the ground.

1534. Plantations in the United States are not always raised from seeds, however, but more frequently from young plants. In planting these the plough is for the most part used, and in the following two ways—1st, The land being previously ploughed and harrowed, furrows are drawn from side to side of the field, at the exact distance apart at which it is intended to plant the young trees, say at 6 feet apart. The field being marked off in this way by parallel furrows, others are next run across them, at the same distance apart, and so as to mark off the whole field into squares of 6 feet on the side; and at the intersections of these furrows the plants are inserted with the spade. 2d, The spade is not always used for planting, however, as when it is considered desirable to have the work speedily and cheaply performed, the plough only is used, and in this way:—Furrows are drawn in the first place from side to side of the field, and at 6 feet apart, as in the former case; but instead of crossing these by other furrows at the same distance apart, the men plough the whole of the land across, while a lad puts in the plants at the desired distance apart as the work of ploughing proceeds, observing to insert them on the lines of the furrows first made, and in this way the roots of the young trees are covered by the plough, and the work of planting completed.

1535. In planting young trees on old woodland in the United States, holes are made for the reception of the young trees, in the same way as we do in Great Britain. In such cases, however, a supply of young trees can generally be had from the seedlings that grow up naturally in the districts.

1536. In Canada planting is performed in most cases in ways similar to those described in respect to planting in the States of the Union. In the province of Manitoba, however, young trees are sometimes planted on lines ploughed each 3 feet in breadth, and from 6 to 8 feet apart; thus leaving strips of unploughed land 3 and 4 feet in breadth between the lines of trees planted. These unploughed strips are meant to prevent drought from injuring the roots of the young plants, and to protect them by the herbage that grows on them. Planting in the older parts of Canada is generally performed by making holes for the trees, and here also the most of the young trees used are obtained from the plants that grow naturally on the districts. These generally succeed well when properly chosen, as there is the great advantage of the plants being planted at once as they are removed, and of their sustaining little or no check from exposure to the air.

1537. In Australia planting is generally performed by making pits or holes for the young trees, as this method is found to be more certain in its results than that of sowing the seeds on the spots intended for the trees. Sowing has indeed been put into practice to some extent here, but the extreme dryness of the climate is found to prevent the seeds from vegetating to a large extent, and therefore this method has not proved so satisfactory as that of rearing the young plants in nurseries, and planting them out into the forest ground afterwards.

1538. In New Zealand, where the climate is comparatively moist, tree seeds vegetate much more readily than in Australia, and in consequence this method of rearing tree crops has been put into practice to a considerable extent: still even here the greater part of plantations are reared by planting the young trees in holes.

1539. In the colony of South Africa a large proportion of the existing plantations has been reared by sowing the seeds of the trees on the spots where they grow, all in the same way as has been described in respect to this method as it is practised in the United States of America.

SECTION VI.—WHETHER SHOULD PLANTATIONS BE REARED BY SOWING THE SEEDS OF THE TREES ON THE SPOTS WHERE THEY ARE INTENDED TO BE GROWN, OR BY RAISING THE YOUNG PLANTS IN THE NURSERIES AND PLANTING THEM OUT AFTERWARDS?

1540. This is a point in forestry upon which much interest is taken at the present time, and on which many experiments have been and are being made in various parts of the world, and for this reason it requires a passing note from us in a work of this kind. We have made experiments to some extent on this branch of forestry, and the result of our experience is, that plantations can be reared much more cheaply and satisfactorily by raising the young trees in nurseries, and afterwards planting them out into the forest land, than by sowing the seeds of the different kinds at once on the land where the trees are to grow to timber. We have indeed found that an individual forest plant, raised from seed sown at once on the land where it is to grow up as a tree, attains larger dimensions within a given time, say twenty years, than one of the same sort reared first in a nursery and afterwards transplanted out into the forest; but we have not found that a plantation of any considerable extent can be reared from seeds sown on the forest land so profitably and so satisfactorily as we have had plantations reared by planting the subjects out from the nursery.

1541. The sowing of tree seeds at once on the forest land has been largely put into practice in the United States of America; but many of those who have reared their tree crops in this way in that part of the world have told us that rearing plantations from seeds sown at once on the forest land is attended with much greater trouble and expense than rearing them from plants. We have examined many of the plantations in America which have been reared from seeds sown at once on the land, and we have, in most cases, found the crops of a patchy and irregular character: on some parts the trees were tall, say 10 feet high, on other parts they were not over half of that height, while on other parts they were not more than 2 feet high. The cause of this difference in the height of the trees forming the crops was explained to us on the spot by the proprietors. They said that many of the seeds they got turned out bad, and failed to grow; that in many cases blanks were caused by seeds having been sown too deep or too shallow, whereby they failed to vegetate; that late frosts killed many of the young plants after they had risen above ground; that birds and mice destroyed a large portion of the nuts; that weeds choked many of the plants; and that the frost of the first winter after sowing destroyed many. All these failures had to be made good the second year, partly by resowing, and partly by planting from the subjects thinned out where the plants had succeeded. Such resowing and planting did not always succeed, however, and generally these operations had to be performed in the third, and even in the fourth year after the first sowing, before the crops could be made complete, and it was this state of things that gave the crops the irregular and patchy look referred to: that is, the plants which came away from the first sowing were tall, those of the second less so, those of the third still less so, while those of the last year's sowing and planting were not much above the surface.

1542. We have, however, seen some plantations in America that were reared from seeds sown at once on the land looking very well indeed; and these were where a successful hit had been made during a favourable season. Still, looking on these plantations as a whole, we were bound to come to the conclusion on their field, that, taking everything into account regarding them, well managed plantations, reared from plants raised in a nursery, were cheaper and more satisfactory in their results.

1543. In Australia, New Zealand, and South Africa, a considerable extent of woods has been reared from seeds sown on the land, but in nearly all of these cases the crops are found patchy and irregular, and not equal, as a whole, to crops reared from young trees planted out from nurseries. Foresters in Britain should, however, make experiments on this branch of tree-culture, in order to satisfy themselves as to its advantages and disadvantages. As for ourselves, we recommend planting as the rule, and sowing only where planting cannot, from some particular circumstances of soil, be well put in operation.

SECTION VII.—DISTANCES AT WHICH YOUNG TREES SHOULD BE PLANTED ONE FROM ANOTHER.

1544. Every proprietor of land, in planting a portion of it with trees, has in view, first, the cheapest possible way of doing the work consistent with future profit; second, the raising of the greatest possible rental from the land under a crop of wood; and third, the quickest possible way of producing both shelter and timber from the land planted.

1545. We may suppose forest-lands to be divided naturally into three distinct localities—namely, sheltered and low-lying, moderately sheltered and low-lying, and high-lying and much exposed. Each of these demands our particular attention, in order to come to a right conclusion as to the proper distance for planting trees. First, then, with regard to the distance at which young trees should be planted in a sheltered and low-lying situation. Every one is aware that trees will in such a situation grow more freely without any artificial means being used to protect them, than the same trees would were they to be planted in an exposed part. The artificial means used by experienced planters for the protection of young trees growing upon an exposed part are, to plant them pretty closely together, so that they may soon come to shelter one another; therefore, in a sheltered part of the country, where trees do not require any artificial rearing, they may be planted at any distance consistent with future good management and profit; and this must be regulated according to the demand for the various sizes of wood required in the neighbourhood. Let us take an example here of two estates, both alike situated in a low-lying and sheltered part of the country, but the one in a neighbourhood where small wood is much in demand, and the other where no such wood could be sold to advantage. In the case of the former proprietor, whose estate was situated in a neighbourhood where small trees or thinnings were much in demand, it would not be wisdom in him to plant at such wide distances that he could not thin out any for sale till his trees become nearly of timber size. In such a case they might be planted at 4 feet apart. Again, in the case of the proprietor whose estate was situated in a neighbourhood where no small wood could be sold to advantage, it would not be wisdom in him to plant his trees so closely as the other proprietor, seeing he required no artificial shelter for their health, and that he could not get any of the small thinnings sold as they were taken out in order to give the others room? Undoubtedly, in such a case, his wisdom would be to plant his trees at such distances that they could come to a size fit for useful purposes in the neighbourhood before he would have occasion to thin. In these two comparisons the whole secret as to distance in planting in sheltered localities lies. In such situations they might be planted at 5 feet apart, as at this distance tree from tree they will be able to stand together till such a time as they will be, when cut down, fit for the most useful country purposes, without doing injury to one another.

1546. Again, trees growing upon what may be termed moderately low-lying and sheltered parts of the country, or in a situation between sheltered and exposed, ought to be, laying aside every local consideration as to the sale of the thinnings, planted more closely than those in a sheltered part, and that on account of the health of the trees individually, as well as of the plantation as a whole. This is evident; for in order to make up for the shelter possessed by trees in a naturally sheltered site, those in a less sheltered part, in order to give them equal advantage, require to be planted so closely as to produce shelter to one another artificially, and that to as great an extent as the nature of the site may demand. In such situations, again, we would advise to plant at 4 feet apart. At distances much wider than 4 feet, the young trees would not prosper well, but would be much checked by exposure and want of due shelter.

1547. In all situations which may be termed high-lying, and therefore exposed, or very exposed, no young trees, if wished to prosper at all, should be planted more widely than 3½ feet, whether the first thinnings may meet with a ready market or not. The great point to be aimed at in the growing of timber in such situations, is to produce shelter as quickly as possible among the trees themselves; and this can only be done by planting rather closely in the outset. Even although a portion of the trees should be cut out as they become too close, and allowed to lie as useless and unsold, no objection should be made: they will have answered their purpose, namely, that of producing artificial shelter for a time, and of rearing up the whole as a plantation much more healthily and quickly than could have been done without them.

1548. These considerations comprise, we think, the whole art of judging as to the distance at which trees should be planted in any given locality of country. This distance will in all cases be regulated by the demand for timber in the neighbourhood, whether that may be for small or large, or both together, and at the same time by the site of the ground to be planted. If the site be a sheltered one, the trees may be planted more thinly, as local circumstances may demand; and if an exposed one, for the sake of the general and future health of the plantation, the trees must be planted closely in order to produce artificial shelter.

1549. We conclude this section, then, by stating generally, that on low-lying and naturally sheltered parts of the country we plant hardwood at 15 feet apart, and make up with nurses to 5 feet over all; that on moderately sheltered parts we plant hardwoods at 12 feet apart, and make up with nurses to 4 feet over all; and that on high-lying and exposed parts we plant pine and larch only, at distances varying from 3½ to 4 feet, as the case may be.

SECTION VIII.—PLANTING ON MOUNTAINOUS DISTRICTS OF THE COUNTRY.

1550. In making plantations on what may properly be termed mountainous parts of the country—say at elevations ranging from 1000 to nearly 2000 feet above the level of the sea—they should always have a very much larger area than plantations on a lower lying part of the country. This will appear evident when it is considered that trees planted on such high-lying parts are exposed to storms of wind from all points, and that unless they are planted in such large masses as to secure shelter among themselves, they could not prosper individually, nor come to any considerable value as a crop on the whole. As a rule, the higher-lying the site of a plantation is, the larger its extent ought to be, and that in order the more certainly to secure the advantages of artificial shelter in degree as the means of natural shelter are wanting. The want of attention to this very essential point in dealing with plantations in very high-lying or mountainous parts of the country is the cause of many of the existing plantations on such districts being found of so very little value to their proprietors. In the Highlands of Scotland, as well as in many parts of the northern counties of England, we find plantations on sites fully 1500 feet above the sea-level which extend to only a few acres in each case, and the result is that the crops are stunted and comparatively worthless, whether as shelter to their neighbourhoods or for producing timber. Had these plantations been made to extend over some 300 or 400 acres in each case, their crops would have been very much more valuable per acre to their proprietors in every respect; and had they been made still larger in extent, they would have been even more valuable—the value of plantations per acre generally increasing on mountainous districts with their extent.

1551. The extent of a plantation in a mountainous district having been fixed upon, and properly enclosed, the next point to attend to is the *draining* of all parts of the land that are found either *wet* or *retentive in the subsoil.* There is, generally speaking, far too little attention paid to this very important point by most planters even at the present day, the greater number being satisfied to make a few open cuts on absolutely wet spots, thinking that it is unnecessary to expend money on land naturally poor—at least, so they reason—for the purpose of growing a crop of trees. This is one of the greatest mistakes that obtains in tree-culture at the present day; and therefore we repeat here what we have already stated and explained in a former section which has special reference to the subject, that "all lands not of a deep, porous, and dry character, must be made so by deep drainage before the planting of trees is undertaken on them." Indeed the advantages of deep and thorough drainage to lands planted with trees is but imperfectly understood as yet, and is by most people very much under-estimated. This is the more to be wondered at when we consider how well the advantages of draining are understood as applied to agricultural lands; for no farmer of any ordinary intelligence would now expend his labour and means on land without first seeing that it was thoroughly drained and rendered porous and suitable for the perfect growth of his crops; and yet proprietors will still go on in the old way, and plant crops of trees on land without draining it, although it is naturally quite unfit for the healthy growth of trees without the operation; and the result of this is seen all over the country in the many unsatisfactory crops of young trees in existence in it.

1552. On all mountainous districts of the country the thorough drainage of the land preparative to planting it with trees is perhaps more necessary than on lower-lying parts, inasmuch as the situation being cold naturally, the land requires to be made as warm as our skill will enable us to make it, in order to counteract the cooling effects of the climate. Therefore, in preparing land for planting on all very high-lying districts, the perfect drainage of it should be attended to with the greatest skill that can be applied to it, for much of the future success of the crop will depend upon how this is carried out; that is to say, if this branch is inefficiently performed, the crop will be insufficient in proportion—and if thoroughly done, it will be valuable accordingly.

1553. It is not, however, the mere removal of surface-water from absolutely wet spots that must be attended to—the drainage must be made to embrace much more than that; it must be applied to remove all retentiveness from the subsoil wherever this is found to exist, as if the work be not carried out on this principle, comparatively little good will be effected, and in consequence the crop will be small in size and value. Wherever retentiveness exists in the subsoil of land, the roots of trees on it are prevented from getting down in search of food; they run along the surface struggling for existence—consequently, from want of sufficient food, and from the effects of exposure in the high climate, they become ere long stunted and unhealthy, and yield a poor return to the planter. But drain the land thoroughly, and the removal of the retentiveness follows: the land becomes gradually open and porous in the subsoil, absorbs heat and nourishment to a great depth (according to the efficiency of the drains); and, as a natural consequence of this improved and healthy state of the soil, the trees send their roots far down into it, deriving large supplies of healthy food, and yielding large supplies of valuable timber to their proprietor.

1554. We are aware that the extent of drainage here implied is generally objected to on the score of the expense it causes in the laying down and making of a new plantation. That it does cost more to do anything carefully and well than to do the same thing carelessly and inefficiently, is apparent to every one; but this is very shallow reasoning, and is not generally entertained in dealing with any other branch of rural economy. What proprietor, for example, would be satisfied with a farmer on his estate who reasoned in this way, and said that the thorough drainage of his land was too expensive an operation for him to undertake, even although it should enable him to pay a higher rent afterwards? Would the proprietor be satisfied with such a tenant? We should think not. And notwithstanding this, the same proprietor acts himself upon the very system of reasoning he condemns in his farmers. We shall not pursue this branch of the subject further, but conclude it by saying, that to be more successful in the rearing of trees than we have been hitherto, we must lay out a larger amount of capital on the preparation of the land for them than has yet been expended, as every agriculturist has to do in respect to the rearing of his crops. A larger amount of capital must be applied to the thorough drainage of the land before planting it, in order to make it porous and open for the roots of the trees. Where this is not attended to, scanty and unprofitable crops will continue to be the result, as has been the case hitherto; but where a more intelligent mode is pursued, and the land is properly improved by thorough drainage, valuable crops of trees will follow, repaying their proprietors tenfold for the extra expense they had judiciously incurred at the outset.

1555. The fencing and draining completed in respect to a new plantation on a mountainous district of the country, the nature of the soil and surface-herbage should next be considered, with a view to judging what kinds and sizes of plants should be used. In all probability, however, it will be found most advantageous, on such a high-lying part of the country as we are now supposing we have to deal with, to plant pines and larch only; therefore, in the case in hand, we shall suppose that, taking everything into account, the situation is too high-lying for the profitable cultivation of any of the hardwood kinds of trees. Then as to the sizes of the pines and larch to be used, this will have to be regulated by the nature and strength of the herbage growing on the surface. On the lower-lying parts of the land embraced, there are likely to be hollows and flat portions on which the herbage is grass with ferns intermixed. On such parts both grass and ferns are likely to grow to considerable strength in the summer time, and consequently plants of a strong and somewhat tall description will have to be used—say larch and pine of the age called one-year seedlings two years transplanted, the former averaging 18 and the latter 9 inches in height. For these pits will have to be made, as it would be unsafe to plant young trees of such sizes by the common system of notching. The pits for these may be made the breadth of a common spade on the side of the square, and at least 10 inches deep; and in making them, attention should be paid to loosen the earth in the bottom of each pit with a pick, after it is made to the desired depth. The pits for this class of plants should be all made at least three months previous to the time of planting, in order that the soil thrown out and that on the sides and bottoms of the pits may have become ameliorated by the action of the weather before it is put to the roots of the plants. The larch and pine may be used here in equal proportions.

1556. The lower parts of the land having been taken into consideration, and proposed to be dealt with as described in the last paragraph, the condition of the herbage on the surface of the parts lying next above these will have now to be attended to before deciding as to the size of plants to be used on them. The herbage of these may be heath, or it may be of a grassy description, according to the geological formation of the district; but in either case, from its being at a higher elevation and on a poorer quality of land than that on the lower-lying parts, it will not attain nearly the same strength in summer, and consequently a smaller size of plants may be used on these parts—say Scots pine and larch, one-year seedlings one year transplanted, in equal proportions. These being of a small size, the former probably 4 inches and the latter 9 inches high, may be all planted by the common system of notching.

1557. With regard to the highest-lying portions of an enclosure to be planted in a mountainous district, the herbage on them is generally of a very short description, and for the most part consists of heath without the intermixture of any other plant, at least to any extent; and here the soil is for the most part so poor and thin that no plant in the form of a tree will succeed on it equal to the Scots pine—therefore this tree alone should be planted on those parts. The plants should be of the class called one-year seedlings one year transplanted, which are always well supplied with roots in proportion to the size of their tops, and when well planted never fail to succeed well even in high sites at nearly 2000 feet of elevation—that is to say, if the plantation is of large extent, and the plants are used at distances not wider than 3½ feet apart. This class of plants may be planted by the common system of notching, or with the *planting-iron*, as is generally done in the planting of high-lying districts in Scotland.

1558. In planting on mountainous districts, no plants should be used but such as have been reared on exposed and airy sites, and on land that is rather poor than otherwise. Plants taken from rich ground in sheltered nurseries never succeed well when planted out on mountainous districts. Therefore, in attending to planting on such parts of the country, this fact should be kept in view, as otherwise much loss and disappointment may ensue.

SECTION IX.—PLANTING ON MODERATELY ELEVATED DISTRICTS OF THE COUNTRY.

1559. The moderately elevated parts of Britain—say those from 500 up to nearly 1000 feet above the level of the sea—embrace a large extent of the area of the country, and are found chiefly in the southern and midland counties of Scotland, in the northern counties of England, and in Wales. Their soil is, for the most part, of a light description, well adapted to the healthy growth of all the coniferous trees, while the surface is undulating, presenting varied aspects within comparatively small areas. Here the soil is for the most part of a richer nature than obtains on higher-lying districts, and in consequence the natural herbage is generally of a grassy character, with comparatively little heath.

1560. The soils and sites embraced under this head are found the most favourable in the country for the healthy and profitable rearing of the pine, larch, Picea, Abies, and other coniferæ, whether of the early or recently introduced sorts; and on the lower-lying parts of many of the districts, a number of the hardwoods are cultivated to valuable dimensions.

1561. In planting on the parts of the country included here, the enclosures do not require to be made nearly so large as is found necessary on the mountainous parts of the country, as artificial shelter is not so necessary for the health of the crops; therefore, in planting on all moderately elevated parts of the country, the enclosures may be very properly made of any convenient extent, according to the purpose intended—always keeping in view, however, that on the higher parts they should be made larger than on the lower parts, and on exposed slopes larger than in hollows and flat parts.

1562. Supposing that an enclosure has been properly fenced for a plantation of some 200 acres on a site averaging some 700 feet above the level of the sea, the land should next be drained in all respects as has been advised for the draining of the land preparative to making plantations on the mountainous districts of the country, observing to apply the operation not only to the absolutely wet portions of the land, but to all those that have a retentive subsoil as well; and this performed, the land should be allowed to lie under the action of the drains for at least six months before planting is undertaken; indeed no land requiring to be drained, whether with a view to remove absolute wetness or retentiveness in the subsoil, should be planted till the drains have had time to operate to some extent on it, and this requires at least six months.

1563. As the herbage on the surface of land situated at an elevation of 700 feet is, generally speaking, of a strong-growing nature in summer, the plants used must be proportionally strong also; as, were small plants used, the herbage would choke them, and probably kill many of them the very first year after planting. Therefore, in planting on such an enclosure as we are now supposing to have to deal with, hardwoods should be planted on the better portions of the land situated on the lower parts, say of sizes not under 2 feet high, as the case may be, and at 16 feet apart. As nurses among these, larch and pine may be used, in equal proportions, to 4 feet over all. The larch portion of these nurses should be of a class of plants not much under 2 feet high, and the pine portion not under 9 inches. All the other parts of the enclosure, which are here supposed to be higher-lying than those just referred to, may be planted with larch from 15 to 18 inches high, and with pine from 6 to 9 inches high, in such proportions as may be considered most judicious on taking the nature of the land and everything in connection with the case into consideration.

1564. We have referred only to hardwoods, larch, and pine, as the trees to be planted; but with regard to planting on such districts, it must be remarked that firs, Piceas, and other coniferæ, may on many parts be used as well, all according to the nature of the land and situation, and as may be the object in view in making the plantation —for it is on such lands and sites that many of the newer coniferæ thrive best; and therefore the kinds of trees to be used must always be judged of by the proprietor and his forester according to all the circumstances of the case, as no absolute rule of guidance can be laid down for carrying out such works, our object here being merely that of giving the parties concerned general hints in respect to them.

1565. In planting on such situations as are here understood to be under notice, as the plants used are in all cases necessarily of a pretty large size, they should never be planted otherwise than in pits, for the reason that large plants never succeed well when planted by the notching system. Therefore, after the drainage of an enclosure to be planted on a moderately elevated part of the country shall have been completed, pits should be made for the trees, at the proper distances apart, as the case may be, observing to make those for the hardwoods about 15 inches on the side of the square, and those for the pines and other coniferous trees about 9 inches, and to take particular care to loosen the subsoil in the bottom of every pit with the pick after it has been made to the specified depth. An important point to attend to in planting trees in pits is to allow the pits to lie open for a period of at least three months, in order to improve the soil thrown out of them before it be returned and put about the roots of the young trees. This is a point in forest management by far too little attended to generally. Indeed we seldom see young trees that have been planted in pits immediately when they were opened come into growth quickly; whereas, when the earth has been exposed for a considerable time before it is put to the roots of the plants, they are found to take readily with their new sites and grow freely.

1566. We ought to remark here that, in dealing with plantations on moderately elevated parts of the country, the herbage may not always be found of such a strong character as to necessitate the planting of the trees in pits, as some parts of it may be found to consist of heath or of very short grass, &c. &c. On all such parts, then, where the herbage is short and the site comparatively high-lying, the plants may be planted by the common system of notching; but in no case should this plan be resorted to where the herbage is strong, and when the plants used are strong also.

SECTION X.—PLANTING ON LOW-LYING DISTRICTS OF THE COUNTRY.

1567. In planting on low-lying parts of the country—namely, those under 500 feet in elevation above the sea—the chief preparative point to attend to is the perfect drainage of the land, as here there is not, generally speaking, the same degree of natural drainage in operation that obtains in higher-lying parts, where the land is generally undulating and hilly. Next after fencing an enclosure for planting on a low-lying part of the county, *Drainage* should be particularly attended to, as unless this be well planned and judiciously carried out, according to the nature of the land, much of it will remain cold and wet in the subsoil, especially on the flatter and hollow-lying portions, and in consequence the crop on such parts will be certain to prove unsatisfactory.

1568. On such parts as are under notice, all the hard-wooded kinds of trees may be planted, suiting each sort to the various characters of the land embraced in the enclosure; and these may be planted in groups of each kind separately or intermixed, all as the circumstances of the case or the object of the planter may suggest; and the nurses for these may be larch, pine, or fir, or all of these, in various proportions of intermixture, according to the nature of the land and the prospect of sale or use for thinnings as these required to be removed.

1569. Supposing an enclosure is made on a site at say 250 feet in elevation above the sea, and supposing the land is a good strong loam, which has been thoroughly well dried by open cuts in the way suggested in the section which has special reference to draining, it will then be in a fit state for planting, but not, it must be always kept in view, till after the drains shall have acted at least six months on the land. The drainage having been properly attended to, however, and the kinds of trees to be planted having been fixed upon, the next point to consider is the particular sizes of trees and the mode of planting them. On such a low-lying district, where the herbage must be very strong in the summer time, plants of large size will have to be used; and of course from this they will all have to be planted in pits.

1570. The hard-wooded species for the permanent crop will, in such a case as is under notice, have to be of sizes ranging between 3 and 4 feet high; while the nurses, if larch, will have to be of a class of plants ranging from 24 to 30 inches, and if pines, of a class of plants about 12 inches high. These may be planted at such distances apart as the nature of the case may suggest.

1571. Three months before the season for planting commences, however, the pits for the young trees should all be made, in order that the soil taken out of them, as well as that on their sides and bottoms, may be improved by the action of the weather before it is returned on the roots of the plants. The pits for the hardwoods should be made 15 inches on the side of the square, and those for the nurses 9 inches, and the soil in the bottoms should be well loosened with the pick.

1572. In planting on parts of the country between 300 and 500 feet in elevation, especially if the sites are not *locally low-lying*, but rather what may be termed of open and airy exposures, and if the soils are deep, open-bottomed, and naturally dry, many of the newer coniferæ should be used, not as nurses, but as permanent crops, with larch among them as nurses. In planting crops of the newer coniferæ on parts of plantations, the larch should always be used as nurses to them, as these are of an open and airy habit of growth, and are not calculated to confine the permanent trees too much when standing near them, as is the case when evergreen pines or firs are used for the purpose.

1573. The districts of the country embraced under this head are of all others the best adapted for the growth of a wide range of species, whether of the hardwood kinds or of the coniferous, as, on the lower-lying parts, where the soil is generally of a heavy and strong nature, the deciduous trees of all kinds attain their largest and most valuable dimensions; while on the higher-lying parts of the districts, where the soil is generally of a lighter and drier character, all the coniferous trees, even those that may be considered somewhat tender on higher-lying sites, find congenial soils and exposures, and attain their best dimensions with us.

SECTION XI.—HINTS IN REGARD TO THE PLANTING OF WASTE LANDS.

1574. By the term *waste lands* we mean districts of a country which are either too high-lying for profitable agriculture in their present unsheltered state, or of too poor and unpromising a character to make certain of their cultivation being remunerative to the farmer. To these two classes of waste lands we shall very briefly advert, and give only a hint as to how they should be dealt with in order to secure their improvement.

1575. Of the class of waste lands first named—viz., those which are too high-lying for profitable agriculture in their present exposed condition—there is a large extent in the north of Scotland, in the north of England, in Wales, and in the north and west of Ireland. In all these parts of the country there are extensive tracts of land on which the natural herbage is generally poor from exposure to storm, and from which only a very small rental can be obtained in their present unsheltered state. The land on the parts referred to is not generally so poor in its natural constituent parts as to prevent its cultivation being profitable, but its altitude and general exposure to storm has hitherto prevented farmers embarking their means on its improvement, well knowing that without shelter it would not yield them a remunerative return; and therefore they use it as pasture fields for sheep only, or for cattle of an inferior description, for which they pay only a nominal rent to the proprietor. Now, were these high-lying districts judiciously clothed with plantations, so as to produce shelter and thus improve their climate, excellent farming land might be made available on them, capable of producing good crops for the rearing of first-class cattle, and of yielding a high return to their proprietors, independent of the value of the plantations as a tree crop.

1576. In many other countries besides Britain there are extensive regions of land similarly situated as to altitude and exposure to storm, and which are, at the present day, comparatively worthless to their proprietors — whether these may be governments or private individuals—producing in their present exposed and unsheltered state only a poor herbage, on which the better class of farm animals cannot be maintained. In all such cases, however, a judicious clothing of plantations spread over them is all that is necessary to secure the lands becoming highly valuable to the agriculturist.

1577. With regard to the other class of waste lands referred to—viz., those that are of too poor and unpromising a character to insure their cultivation being remunerative to the farmer—we have to explain that it consists of poor, generally sandy wastes, situated on the lower-lying parts of a country. In Britain there is but little of this class now left for improvement, as within the last fifty years it has been nearly all taken into the hands of agriculturists, and made highly remunerative; but in many other countries, and specifically in Australia, South Africa, Canada, and in the United States, there are very extensive districts of it, yielding only a coarse and worthless pasture and a few stunted trees here and there. And let it be understood here that the poorness of the natural crop on such districts does not arise so much from the constituents of the land being defective for agricultural crops, as from the storms that spend their forces over them unchecked preventing plants of any value attaining sufficient growth upon them.

1578. Here also is a great field for improvement by tree planting—not only in an agricultural point of view, but in a climatic as well; for were the extensive plains understood to be referred to under this head properly clothed with well-arranged plantations, the climates would become more moist and cool, rainfall would increase, and with these advantages the land would become productive, and therefore remunerative to all concerned. We throw out these hints to the inhabitants of the countries referred to, as we are aware that at the present their Governments are discussing whether or not their at present worthless plains can be made more advantageous to these countries than they now are. We repeat it, therefore, with all confidence in the result: Clothe these tracts of waste with trees in a proper manner, and ere long the land of them will become valuable for farms, while the plantations will not only improve the climate, but also prove a source of great revenue to the states to which they belong.

SECTION XII.—PLANTING ON LAND LATELY CLEARED OF A CROP OF TIMBER.

1579. Having referred to this subject in the second section of Chapter V. of this work, it is not necessary that we should enter into any lengthened remarks on it here: still, as planting on land lately cleared of a crop of timber is a branch of arboriculture requiring careful management on the part of the forester in order to be perfectly successful, we have thought it right to devote a short section to the subject, in order to bring its leading points still more prominently under the notice of the forester than has been done in the one referred to.

1580. First, then, where it is found desirable to replant a district that has been newly cleared of a crop of trees, no time should be lost in immediately getting all the refuse left from the former crop cleared from the land, by collecting and burning it upon the spot. Not only should all the branches left on the ground be thus consumed, but every piece of bark as well that may be found lying on the surface: indeed every piece of wood, in whatever shape it may be found, should be so consumed. All the bark on the old stumps should be stripped off and consumed also, in order to prevent the lodgment of the pine-beetle in the case of the stumps of pine-trees, and to prevent the growth of young shoots from the stumps of the hardwood kinds.

1581. The land perfectly cleared of all remains of woody matter that may have been left from the former crop, it should next be drained in a systematic way, as specified in sections first and second of Chapter VI. This drainage should be performed systematically over all the land embraced without any reserve whatever, whether it may seem wet or dry, as the object is to cleanse it both in the upper surface and subsoil, and to make it in all respects wholesome and fit for another crop. After the drainage has been performed, all the earth thrown out of the cuts should be spread in a regular manner over the land between them, in order to improve the surface.

1582. After the works described have been completed, the land should be allowed to lie for a period of about four years, when it will have become so cleansed and renewed as to be in a fit condition for being replanted with another crop, which may be afterwards dealt with according to the nature of the land and its site in the country, whether that may be in a mountainous district, in one moderately elevated, or on a low-lying part.

1583. In all cases of planting on land which has been cleared of a crop of timber, however, pits should be prepared for the young trees six months before the work of planting is commenced; and in making the pits, all roots of the old trees should be taken out as they come in the way, and these should not be left lying on the ground, but should be carefully removed as may be found most convenient. These pits may be made of sizes suitable for the kinds of trees to be planted—that is, 15 inches on the side of the square if for hardwoods, and about 9 inches on the side of the square if for coniferous kinds.

1584. If any piece of land which has been cleared of a crop of trees be dealt with in the way described, it will not fail to produce a crop of trees even better than the one removed, as it is so much improved by the operation of drainage, and by the time it has lain under its action, that the young trees will be found to succeed vigorously from the first year of their being planted.

SECTION XIII.—PLANTING WITHIN THE INFLUENCE OF THE SEA.

1585. On most landed properties lying along the sea-shore, it is found very difficult to get plantations to grow within the blasting influences of the sea-breeze; and to those who wish to rear plantations on such parts of their estates as lie along the sea-shore, we give the following mode of procedure as the best that can be adopted in order to insure them:—

1586. Line off a belt of land all along the length of the coast to be planted, not less than 200 yards in breadth; and, as a fence to this, upon the side next the sea, erect a stone dyke if possible, in order the more readily to bring away the trees by giving them shelter from the sea: this stone dyke should be built 6 feet in height. But if stones for this purpose are not to be got conveniently, erect a turf dyke of about 4 feet in height, and on the top of this a wire fence of 3 feet in height. This wire fence should be closely wattled with branches of spruce fir, or with the branches of any other tree or shrub, as may be found most convenient, the object being, in this case, to secure a fence of about 7 feet in height in all, for the purpose of sifting the sea-breezes, and sheltering the young trees to be planted inside. Care must be taken, upon all juttings of land bending out into the sea, to make in the line of fence a bold convex bend in the same direction—this being in addition to the general width. While the fence is being erected, all wet parts of the belt to be planted should be made thoroughly dry by open cuts, according to the nature of the land; and where any of it is of a retentive nature, it should be drained also, in order to remove the retentiveness, observing to spread the earth taken from the drains regularly over the spaces between them. The works of fencing and draining having been completed in the autumn, the drains will have acted sufficiently on the land to improve it for the reception of the young trees by the month of April following, which is the best time of the year for planting on land lying along the sea-shore. Pits should be made for the reception of the young trees some three months previous to the time of beginning planting, and these should be made at 3 feet apart over all. Everything being prepared for planting by the first week of April, as specified above, the next point to attend to is the kinds of plants to be used: these should be sycamore and Norway maple, from 15 to 18 inches high, and Pinus pinaster, of the class known as one-year seedlings two years transplanted—that is, they must have been twice transplanted, but only 3 years old; for if they have not been transplanted twice, they will be badly supplied with roots, and consequently many if not the greater part of them would fail. The sycamores and Norway maples should be planted in pits prepared for them, at 12 feet apart, using them alternately, or of each an equal number on the ground. Having the hardwood planted, use pinasters in all the other pits, so that when finished there will be young trees all over the ground at 3 feet apart. The hardwood plants will not come away rapidly, and many of them will in all probability die down to the ground the second year after being planted. But the proprietor must not be at all discouraged upon this account, for it is quite natural that the young plants should do so, as they must suffer considerably by being at once transplanted from a nursery to the open ground upon the sea-coast. In order to strengthen such of the young maples and sycamores as show indication of stuntedness, when they have remained one year upon the ground, have them cut over by the surface of the ground in the month of April, and the year following they will set away strong young shoots, which will bear the climate they rise in—the more so, as by this time the pinasters will be beginning to grow rapidly, causing some shelter over the ground. If the ground is not of a nature suited to the healthy growth of the maples, it will be better to plant the ground all over with pinasters alone; for though the maple and sycamore both stand the sea-breezes well, still, if the soil upon which they are planted be very light and mossy, or very thin, as often occurs along the sea-shore, they have not much chance to rise to any good, but would be unsightly things. The pinaster, on the other hand, being a plant that grows in the poorest and lightest soils, will, instead of being injured by being planted even upon the sea-sand, actually flourish upon it.

1587. If the fence is made of sufficient height to produce a proper degree of shelter to the young plants, they will make fair progress, and in a few years will be found to have met together in the spread of their branches, when thinning should be commenced, and this should be attended to as soon as the branches begin to touch each other, so as not to confine the trees; for in no case should they be allowed to grow up in a crowded state, but thinning should be applied very frequently, in order to encourage the full spread of branches in each individual tree. It must not be expected that the pinasters will rise high or make fine-looking tall trees, at least for a considerable number of years. On the contrary, if they are properly attended to in the way of thinning, they will spread rather low, and form a very bushy habit for at least the first twelve years. This habit of theirs is their security—for a tree that would incline to rise high in such a situation would be at once beaten down by the gales from the sea; while the pinasters, spreading themselves, soon form a complete massive shelter to everything else near them, and by the time they arrive at about fifteen years old they begin to rise upwards rapidly, being by this time perfectly established in their situation.

1588. When the trees in the belt now supposed to have been planted along the sea-shore shall have attained the height of some 6 feet, which may be in about eight years after they are planted, other plantations may be planted on the land inside of them with every reasonable prospect of success, as from the shelter afforded by the sea-side belt they would be in the position of trees planted inland at a considerable distance from the sea. In making plantations inside of the sea-side or first belt, any kinds of trees suitable for the land may be used, as they will be now perfectly screened from the blasting influences of the sea-breezes, and therefore may be dealt with in the usual way, as the nature of the case may require—and thus the object in view will have been gained.

1589. Were such a belt as we have described carried along all the higher ground of the sea-boundary of an estate, the advantages to it would be immense, both in an arboricultural and an agricultural point of view; for its ameliorating influences would place the whole of the property in the position of one situated several miles inland, and in consequence fine thriving plantations of all other kinds of trees could be reared on it; while agriculture could be as profitably pursued on the other hand.

1590. In planting within the influence of the sea, although the pinaster, Norway maple, and sycamore should be the principal trees used, still, for the sake of variety on certain parts where this may be an object with the proprietor, many other trees may be used which stand well, and even prosper on such sites—namely, the common beech, the common yew, the evergreen oak, the Turkey oak, the pear-tree, the black Austrian pine, *Pinus pumilio*, the Corsican pine, the elder, the mountain-ash, the service-tree, and we may also name the Huntingdon willow and the Bedford willow, with the Abele and Ontario poplars; and for underwood the common broom and furze may be used, together with sea-buckthorn, the guelder rose, the common hawthorn, the Scotch rose, the snowberry, the common Mahonia, the evergreen barberry, and the privet, all of which succeed more or less in situations under the influence of the sea-breeze; but these, of course, should be used only on the more sheltered parts, where variety and effect may be an object. We may remark here, that of all the plants named as suitable for underwood here, the sea-buckthorn is the hardiest, and may safely be used on the most exposed points.

SECTION XIV.—PLANTING UPON LAND OF THE DESCRIPTION TERMED MOSS.

1591. Moss or peat soil consists in general of decayed vegetable matter which has accumulated in a flat or hollow part, having always a retentive bottom. In a state of nature such moss is always full of water, which cannot escape downwards in consequence of the retentive nature of the stratum upon which it lies. The water contained in moss soil can escape only by evaporation from the surface; and from this it is evident that its surface must at all times be cold as compared with others lying upon an open or porous subsoil. It is also in consequence of this cold nature of moss-land that we never find any valuable or useful plants growing upon it, but only a few birch or alder, or, it may be, some heath and rough grasses. Moss-land, even after being dried by drainage, is found of a dull and inert character, and not apt to give life and energy to the growth of useful plants that may be put upon it. This is the more observable in such moss-lands as are purely of a vegetable character, and without any considerable mixture of inorganic matter, such being generally known by the name of *flow* or *soapy* moss.

1592. There are two different descriptions of moss-land—namely, those holding a portion, less or more, of inorganic matter, and moss of a purely vegetable character; and upon these we have found trees grow differently.

1593. In contemplating to plant moss-land with trees, the very first preparative point to attend to is its perfect drainage, as till this be accomplished no other work can be undertaken on it. The draining of moss-land is performed by open cuts in the usual way of drying other woodlands, but with this exception—they must in all cases be made about one-third deeper than the depth they are intended to remain at permanently,—that is, if it is wished to have the drains to remain at the depth of 4 feet after they have been opened, then, in the first instance, they will have to be made about 5 feet 6 inches deep. This is necessary on account of the great subsidence that always takes place in moss-land after the water is removed from it by drainage; indeed, in the case of very light flow-moss, we have seen the subsidence nearly one-half the original depth of the drains. In draining moss-land for planting with trees, if the moss is not over 6 feet deep, it will be found advantageous to open the cuts down to the bottom, as in this case the land would be made perfectly dry, and therefore more suitable for the healthy growth of trees than if the drains were made with their bottoms resting on the under portion of the moss. To dry moss-land properly for the growth of trees, the drains should be opened to the depth of from 5 to 6 feet in the first place, in order to make allowance for subsidence, and they should be laid on at distances not wider than 35 feet apart. If, however, the moss is shallow, as often happens, the drains need not be made so deep as stated; for example, if the moss is found only about 3 feet deep on the average, then, in order to secure an average depth of 4 feet for the drains after the moss had subsided, they would require to be opened to the depth of 5 feet in the first instance, thus allowing 1 foot for subsidence in the moss on the surface; and so on with any other depth of moss, always allowing one-third of its depth to subside.

1594. In all cases moss-land should lie from twelve to eighteen months under the cleansing action of the drains, as there are generally ingredients lodging in land of this description which are found injurious to the health of young plants, and which require to be removed before planting can be successfully undertaken on it. Therefore this is a point which should never be lost sight of in dealing with planting on moss-lands. Indeed we may here mention that we have seen considerable extents of young plantations which had been planted without this precaution, and immediately after the drainage had been performed, completely fail; while the second planting on the same land, which was done two years after, was perfectly successful, simply from the moss having become cleansed of the bad ingredients which had lodged in it, and which had been removed before the second crop was planted.

1595. All trees should be planted on moss-land by the system of pitting, whatever may be the kind or age, as when the planting is performed on it by the notch system, the cuts generally open and expose the roots to drought, and many of the plants die in consequence. The pits should be all made some six months previous to the time of commencing to plant, in order to cleanse and improve the soil to be placed at the roots of the young trees.

1596. In planting on moss-land having a considerable portion of inorganic matter in it—sand or earths of any description—poplars and willows may be used, of the usual kinds grown for timber, together with spruce and silver firs, and the Scots, black Austrian, Corsican, and Cluster pines, all of which will succeed. These should be planted say at distances not wider than 4 feet; and of course they can be used in such proportions of intermixture as may be considered most suitable to the circumstances of the case. If the situation is one somewhat sheltered, however, the plants need not be used at distances closer than 5 feet, in all cases planting the larger proportion of such kinds as may be considered most likely to come to the greatest good on the soil and site, which can only be determined by the nature of the case in hand at the time.

1597. The plants used should be all of a pretty large size—say the poplars and willows from 3 to 4 feet in height, and the firs and pines from 9 to 12 inches. But if the situation be at all an exposed one, then plants somewhat smaller should be used—say poplars and willows about 30 inches high, and firs and pines from 6 to 9 inches.

1598. If the moss is not over 3 feet deep, oak and ash, elm and birch, may be used with fair success, as these kinds, when their roots get down into the subsoil, generally thrive well; still, as a profitable crop on moss-land, the kinds first named will be found the most desirable. The birch, in particular, we have found to thrive well on thin moss resting on a substratum of clay, and even the elm and oak, and where variety is an object in the crop, these may be used with less or more success.

1599. As the most profitable crop on sandy moss, in a high-lying situation, there is no tree that will come to so useful and profitable an account as the Scots pine. We have ample proof of this in many parts of the north of Scotland and in the north of England, and especially on many parts of the natural forests in the districts of Braemar, Abernethy, Duthal, Rothiemurchus, Glenmore, and others. In these districts there are large tracts of moss-land containing a considerable portion of sand, on which we find the Scots pine has attained very respectable dimensions.

1600. Relative to moss-land of a purely vegetable character, it should of course be drained in all respects as has been stated in regard to that holding inorganic matter in it; and before planting on it, the pits should be prepared in the same way. In planting on moss of a purely vegetable character, however, only the Scots pine and the spruce fir should be used, as no other trees will come to the same dimensions upon it. We have indeed seen silver fir, oak, and some other hardwood kinds used; and where the moss was so thin that their roots reached down to the subsoil before they had attained any considerable age, they did well; but where it was so deep as to prevent the roots getting down to the subsoil, they soon became stunted and unhealthy, and died off prematurely. From this, therefore, the planter on moss-land will at once see that he should in all cases suit the trees to the conditions of the moss—in respect to whether it is deep or shallow.

1601. From the foregoing statements relative to the growth of trees upon moss-land, it will appear that Scots pine, spruce and silver firs, willows, poplars, and birch, stand first in order as trees adapted for growing upon it to useful size. This statement must, however, be understood with the qualification, that if the situation be very high-lying and exposed, silver and spruce firs, willows, and poplars will not do well. Under such circumstances, Scots pines and birch would be more suitable, as being hardy and adapted for a high situation. It may be observed, further, that the black Austrian, the Corsican, and the Cluster pines, as also the hardwoods named, should not be used on moss-land, excepting where it is on comparatively low-lying or moderately elevated situations.

SECTION XV.—KINDS OF TREES BEST SUITED TO GROW AS A CROP FOR A SUPPLY OF POWDER-WOOD.

1602. This is a branch of arboriculture generally too little attended to, which is the more remarkable when we consider the value of wood suitable for powder-manufacturers, and the large extent of waste land in the country which might, with great advantage to its owners, be made to yield crops suitable for this purpose. Indeed in the north of Scotland, and in the northern counties of England, there are large tracts of high-lying ground at present yielding only a stunted and unprofitable herbage, which, were they planted with plants suitable for the manufacture of powder, might be made to yield handsome rentals. This class of wood-produce, not requiring to be of large dimensions, could be the more easily reared in high-lying districts of the country, and consequently could be conveyed with little trouble to the places where it was to be used.

1603. Perhaps it is not generally known that a large supply of the wood used in this country for the manufacture of the finer kinds of powder for small-arms and fowling-pieces is imported from Belgium and Prussia. The wood which is chiefly imported for this purpose is that of the *Rhamnus frangula*, a small tree found to be of the easiest possible cultivation in most kinds of soil; and as it brings from £10 to £14 a-ton, *in the peeled state*, in the British market, it is certainly worth the attention of landed proprietors to cultivate it as a part of their woodland crops. Indeed it is humiliating to the British people that the main supply of wood suited to the manufacture of the finer kinds of powder for small-arms has to be brought from foreign countries, seeing that we might so easily grow it ourselves as a profitable crop in the economy of our landed estates. Having made these remarks in respect to the advantages which would ensue to landed proprietors were they to rear crops of wood specially for the purpose of powder-manufacture, and referred particularly to the *R. frangula* as a plant deserving of the especial attention of all interested in the subject, from the high price obtained for its wood for the purpose, we proceed to give a list of the kinds of trees best suited as wood-produce for the powder-manufacturer; it is as follows:—

1604. *R. frangula*, dogwood of sorts, willows of various species, the common birch, the hazel, the common alder, the mountain-ash, and the common bird-cherry of British woods.

1605. With the exception of the first named, we have grown all the others ourselves for the purpose of producing a supply of powder-wood, and have found them all very profitable as woodland crops when treated in the form of coppice. In growing these kinds for a supply of powder-wood, each should be planted in a district by itself, and should never be mixed with another kind, as each has its peculiar property, and therefore its own value with the powder-manufacturer. Once fairly established on a piece of ground, all these kinds produce heavy crops of shoots, and yield a large return per acre. The shoots should be all treated as coppice in rearing them for a supply of powder-wood; and they may be cut over, stripped of their bark, and sold to the powder-manufacturer at any stage of their growth, as large wood is never wanted for the purpose of powder-making. Indeed, when the growths are comparatively small, a higher price is given for them than for larger ones, as in the young state of the shoots the powder made from them is finer than when made from older and larger growths.

1606. The *R. frangula* is the most valuable of the species named, as it is used for making the very finest kinds of powder. The dogwoods are next in value; and the birch, hazel, and alder are the next in the order of value for powder. The mountain-ash and bird-cherry are comparatively only of a fourth-rate quality, and the willows stand as fifth-rate for the purpose. They are all in use, however, for making different qualities of powder.

SECTION XVI.—KINDS OF TREES BEST FITTED FOR HEDGEROW TIMBER, AND MANAGEMENT OF THE SAME.

1607. At the present time, when agriculture is improving so rapidly, many of its advocates are crying out vehemently against hedgerow timber, declaring to an enlightened public that all hedgerow timber-trees are injurious to the raising of plentiful and healthy crops in the fields upon the edges of which they are planted. That this is true to a certain extent cannot be denied; but hedgerow trees being in some cases injurious to the crops in the adjoining fields cannot so much be attributed to the presence of the trees themselves as to bad management in growing them; for let it be kept in view that anything, however useful in itself when properly managed, if it be allowed to overstep due order and balance, at once becomes an evil instead of a good. This is the very state of a great many hedgerow trees, particularly in England, at the present day. In many cases the kinds of trees have not been adapted to the nature of the soil, thereby causing them to spread too much, and in most the trees have been entirely left to nature, never having been trained up with the view of doing good as shelter to the adjoining fields. They have thus often become a pest; have been allowed to spread out their branches widely upon all sides; have been irregularly and most injudiciously planted; have been topped and mutilated, and made to answer any purpose but that of doing good to the farmer;—in short, hedgerow timber at the present day is a part of forestry the least understood, and yet its proper management is of the greatest importance both to the proprietor and the farmer. Hedgerow trees, when trained up and managed upon right principles, instead of being a nuisance to farmers, become of first-rate importance in all well-cultivated districts; and instead of impoverishing the land, they become a source of fertility to it. But although this may properly be said to be the state of things generally relative to hedgerow trees, there are nevertheless many fine examples of their being well managed; and in such cases farmers say that they are very much benefited by the shelter produced by them, and would not upon any account part with them.

1608. The planting of hedgerow trees is generally done with a threefold view—namely, that of raising useful timber in the country, without occupying much breadth of land exclusively for that purpose; the producing a degree of shelter for stock and crops in the adjoining fields; and the giving the country a clothed and ornamental appearance.

1609. Now, all these three objects can be most amply attained without any injury whatever being done to the agricultural produce of the country. In some districts both in England and Scotland, where of late attention has been paid to the pruning of hedgerow trees, much good has arisen from their influence. In all cases, trees planted in hedgerows are freely exposed to the air, consequently the natural habit of trees under such circumstances is to become branchy; but if the forester apply his knowledge and practical skill to trees under these circumstances, he can, by the timely use of his knife, check this rambling habit, and give them a contrary tendency; and it is in a great measure from the want of this application of timely pruning that a large proportion of the existing hedgerow trees are now of so little value as timber, and so ruinous to the fields. That shelter has been produced to the fields from the existence of trees about them is evident; but then the amount of good which has been done in this respect has been overbalanced by the shade they have cast upon both sides from the spread of their branches, causing a deficiency in the actual crop upon the shaded parts. Thus it cannot be said that much real good has arisen from the presence of hedgerow trees of the older class.

1610. That they are an ornament to the country, and give it a clothed appearance, is admitted by most travellers passing through it. But the farmer, who has his rent to raise off the land, when he looks upon the trees in his hedgerows, and is aware of their doing him much damage, feels no pleasure in them, but becomes desirous to have them removed, in order that he may have the land occupied by them brought into more profitable use.

1611. In travelling through some parts of England, one is particularly struck with the manner in which a great part of the hedgerow trees have been planted—that being upon raised banks of earth, with sometimes a deep ditch on each side, sometimes with a ditch upon the one side and a dyke upon the other. Frequently, too, we find this bank of earth overgrown with thorns, brambles, and other rubbish, making altogether, with the broad-spreading trees, a formidable mass of very considerable extent. This is the state of things that farmers complain of. Now, in order to grow hedgerow trees upon right principles, the trees in this state should be taken out, tiles put into the ditches on each side in order to convert them into proper drains, the bank levelled down over them, the ground trenched, and a requisite quantity of lime put into it in order to decompose all the old roots the more quickly. This being done in the spring months, the ground so dealt with should be well manured and put under green crop: in the autumn a hedge of thorns or beech should be planted in one continuous straight line upon the surface, putting in a young tree among the hedge plants at every 12 yards for hedgerow timber. In the act of renewing the fences in this manner, any alteration could be made that might be considered an improvement upon the old style, such as, in some cases, omitting the renewing of some of the fences altogether, and consequently enlarging the fields so far as might be considered necessary. In some cases a new fence might be made along the middle of a field, thereby making such a new fence upon new land, and converting one field and a half of the old into one of the new; and in the act of making such improvements, the direction of the line of many of the present fences could be altered so as to suit the views of the improver.

1612. A great error has occurred in the rearing of hedgerow timber in planting those sorts of trees which are of a spreading habit, and not easily kept within due bounds. The following trees are the only ones which should be planted in the neighbourhood of fields—the oak, the English elm, the sycamore, the Norway maple, the birch, the sweet-chestnut, the black Italian poplar, and, in some situations, the cracking willow. These are all trees more or less of an upright habit, and such as, by the timely use of the pruning-knife, can be easily kept within due bounds. We often find the ash growing as a hedgerow tree, but it ought very sparingly to be planted under such circumstances. When standing alone and exposed to free air, its top is extremely liable to diverge off into large limbs, and, what is even worse, the roots of the ash are of all other trees the most searching upon land, and impoverish it very much.

The beech is another tree we frequently find growing in hedgerows, but we object to its being used under such circumstances, for these reasons: we have always observed that under the drip of beech-trees a thorn hedge will not prosper; and, as far as our experience goes regarding agriculture, grass and grain do not thrive under it either. Besides, the tree is of a diverging habit when standing alone, and does not do with much pruning when of large size. Another peculiarity of the beech is that, when growing in a free open situation, it is always found leaning to the sheltered side—that is to say, if the prevailing winds of the district be from the west, the tree will be extremely bare of branches upon that side, and over-heavy upon the opposite side, giving it an oblique attitude, which, of course, does not answer in every situation, and more particularly when growing as a hedgerow tree.

1613. The fir and pine tribes are all trees of an upright habit, but they are not adapted for standing alone; they always thrive best when congregated together. Besides, the roots of these trees run too shallow for growing upon the borders of fields, where the plough must have free access to their very stems. No fir or pine tree, therefore, should be planted as a hedgerow tree.

1614. The training up of the young trees planted in hedgerows is a matter of the greatest importance, and should be most perseveringly attended to. We shall suppose that trees of the kinds above recommended for hedgerows have been raised in the nursery for the purpose; and for this purpose every proprietor should raise his own trees, having them frequently transplanted in the nursery, in order to secure every one being well furnished with healthy fibrous roots. These should be pruned and trained into a proper and upright shape, each with a single leader only while in the nursery-ground, and the size of the tree should be from 6 to 8 feet when they are transplanted. If trees for hedgerows are planted of sizes much above these, they do not succeed so well, as they are more apt to grow branchy than tall, which state of things is of course to be avoided where trees of proper character are an object.

1615. The hedgerow being planted with thorns to form the fence, and spaces being left in it at intervals of 12 yards for the trees, have them planted, each kind to answer the nature of the soil as nearly as possible; and upon both hedge and trees being planted, put a fence of paling upon each side if there are to be cattle in the fields, attending to the cutting of the hedge as has been advised in its own place. These hedges, when at their full size, should never be more than 3 feet in diameter at bottom. As the trees advance, let them be regularly pruned, causing each of them to have ultimately a clean stem of from 10 to 15 feet high, in order to allow the hedge under them to have free air; and as the tops of the trees advance in breadth, their branches should be shortened well in, so that, when they have arrived at 30 years old, their side branches may extend only a few feet over the fence upon each side. In order to keep them in this state, they should have their branches shortened in every two or three years; and even when they have attained full size, they should not extend more than 8 or 10 feet over the hedge upon each side. In these things being properly attended to, the whole art of growing hedgerow trees consists.

1616. The advantages of this system over the old one are many, and of vast importance to both landlord and tenant.

By the old system of growing hedge-fences and hedgerow trees, there is generally from 8 to 15 feet in breadth of land wasted, and taken up for that purpose, upon the boundary of every field where they exist; whereas by the method we recommend, and which is being practised in some districts of Britain, only 3 feet in breadth, at most, is occupied by the fence or hedge; and as the trees are not allowed to grow beyond a certain breadth, their shade does not materially injure the crop even when sown close in to the side of the hedge; while, at the same time, from the shelter afforded, the crop is very much improved; and, moreover, the hedges never being allowed to grow above 4½ feet high, and the trees being kept clear of branches on their stems for at least 10 feet up, a free current of air is allowed to pass everywhere, keeping both the hedge and crop upon the land in a healthy state.

The trees, when treated in the manner above recommended, in consequence of being so much kept in upon the side branches, soon become tall, and form fine trunks of timber. In order to gain this end quickly, the top of each tree should have the lead from the very first, and no side branch be allowed to gain strength upon it.

1617. This system of growing trees in the form of hedgerows is, however, adapted only to level and low-lying parts of the country, and not to hilly and exposed parts, as on the latter trees require to be grown in masses, in order to produce shelter both to themselves and to the neighbouring fields.

SECTION XVII.—PLANTING OF LAND HAVING UNDERWOOD OF ANY KIND GROWING ON IT.

1618. It often happens that land to be planted is much overgrown with broom, furze, hazel, and various other kinds of underwood; and wherever any of these are found to prevail, they should be removed by grubbing them out by the roots with the mattock, or by trenching, if necessary, before planting. Broom and furze are, generally speaking, got rid of easily by grubbing them up with the common mattock; but hazel and other such strong-rooted kinds of plants are more difficult to deal with, and it is generally found necessary to trench the ground occupied by them in order to get them entirely removed.

1619. In clearing broom and furze from a piece of land before planting trees upon it, the best way is to let the work of grubbing them to a person by contract, either at so much per acre, or at so much for the whole, according to the extent and character of the underwood to be removed, binding the contractor to take out every plant by the roots. Work of this kind may be got done at various prices, according to the closeness and strength of the plants to be dealt with. We have got patchy crops grubbed at 20s. per acre, while we have had to pay in some cases 70s. per acre; but in the latter case there was a close crop of very strong furze. Taking an average of cases, however, such work may be got done for about 40s. per acre, including the burning of the underwood on the ground. In contracting for work of this kind, the forester requires to look carefully after the contractor, to see that he takes out all the plants by the root. We have frequently seen this kind of work very carelessly performed, a large proportion of the plants having been only cut over under the surface, and in consequence of the roots of such having been thus left in the ground, another crop of whins appeared the year after, as although the plants are cut over under the surface they send up young growths readily from the roots, which ere long form as strong a crop as before. Therefore we repeat that work of this kind requires the careful attention of the forester.

1620. In dealing with the removal of hazel and such strong-rooted plants, however, the case is different, and it is always found necessary to use both the spade and the mattock in order to root them out properly. Where the plants are few on the ground, with large clear spaces between them, it will be found the easiest and cheapest plan to dig out each plant separately, and fill up the hole from which it was taken immediately after; but where the plants form a pretty close crop, or nearly so, on the ground, the cheapest and most satisfactory way is to trench the ground all over, so far as it is occupied by such a close crop. This trenching need not be of a deep character, but only sufficient to enable the contractor for the work—for it should be done by contract also—to get sufficiently deep to take out every plant by the roots: from 1 foot to 15 inches will be found sufficient depth of trenching in order to remove the roots of most kinds of undergrowth, such as is under notice. We have got land trenched in this way, having strong stocks of hazel and birch removed from it which stood at an average distance of 9 feet apart, for £7 an acre. This sum, however, did not include the cost of removing the roots from the land after trenching, as this was done by the proprietor's own workmen apart from the contract.

1621. In planting land that has been cleared from broom or furze by the use of the mattock, the young trees may be put in either by pitting or notching, according to the nature of the situation to be operated on — that is, as it may be in a mountainous, moderately elevated, or low-lying situation; and as we have already referred to planting on each of these, we need not add more on this branch of the subject.

1622. In the case of a piece of land having been trenched for a crop of young trees, it should never, if on an exposed site, be planted immediately afterwards, as in such a case the loose and very open character of the land, while the turf is lying fresh and unrotted in the bottom, would admit drought to such an extent as to prove injurious to a large proportion of the crop. On a high-lying and exposed site, therefore, trenched land should be allowed to lie for a considerable time before it is planted, in order to admit of the partial rotting of the turf and the subsidence of the soil generally. If the trenching is performed in the autumn, however, the land may be safely planted in the spring following.

This precaution is not so necessary in the case of trenched land on a sheltered part, as on such the plants are not nearly so subject to be injured by winds blowing them about.

In all cases of planting on trenched land, young trees of a larger size may be used than is advisable on untrenched land, as in land that has been thoroughly opened up by trenching, the roots of comparatively large plants get away freely into the prepared earth without any obstruction. The size of the plant to be used must in all cases, however, be regulated by the nature of the situation.

SECTION XVIII.—PLANTING WITH THE VIEW OF SECURING A RAPID GROWTH TO BLIND OUT CERTAIN OBJECTS.

1623. In order to secure a rapid growth of trees on any particular part, for the purpose of screening some object it is wished to keep out of view, the first point to attend to is the trenching and manuring of the land to be planted, if that is not already of a deep and rich character. This point secured, the next thing is to use such plants on it as are known to make a rapid growth under ordinary circumstances; these may be stated as under: *Abies Douglasii* and *excelsa*, *Acer pseudo-platanus*, *Ailantus glandulosa*, *Castanea vesca*, *Cupressus Lawsoniana*, *Pinus insignis* and *laricio*, *Platanus occidentalis*, *Sequoia gigantea*, *Robinia pseudacacia*, *Salix alba*, *Populus alba* and *monilifera*.

1624. Although the kinds of trees just named are all of rapid growth under ordinary favourable circumstances of soil and site, still it must be kept in view that, if they are planted on an exposed situation and unfavourable soil, they would not grow nearly so rapidly. For example, the poplars named, when planted on a deep alluvial soil in a sheltered valley, will make annual growths of from 3½ to 4½ feet; while if they are planted on a light gravelly soil on an exposed site they will not make over 2 feet of annual growths: and the same thing holds good in respect to all the other kinds named—that is, in order to secure the rapid growth of any particular one of these species, it must be planted not only in a rich soil, but also in one suited to its requirements in respect to natural component parts and situation.

1625. On a good deep dry soil, and on a situation not exposed, the *Abies Douglasii*, the *Pinus insignis*, and the *Sequoia gigantea* will make annual growths of 30 inches; while on shallow soils, with an exposed aspect, they will not make growths exceeding 12 inches from spring to spring. The *Acer pseudo-platanus*, the *Ailantus glandulosa*, the *Castanea vesca*, the *Platanus occidentalis*, and *Robinia pseudacacia* will, on good strong loams and sheltered sites, often make growths of 3 and 4 feet and upwards in one year; while on soils and sites of an opposite description they make very small growths indeed,—even much less than the Scots pine would do on the same soils and sites. Our meaning for referring to these points is to explain that, in order to secure a rapid growth on any particular part, the trees must in all cases be suited to the soil and situation. The kinds named are adapted to grow rapidly on most soils of a fair description and on sites not much exposed, and of course their rapidity of growth is much encouraged in their first stages when the land has been manured and well prepared for them. It is not to be understood here that we are advocates for the application of manure to trees in general. On the contrary, we are quite opposed to this course where a healthy crop of permanent trees for timber is the object. We recommend manuring only in the case under notice, and that in order to secure the end in view the more rapidly—namely, rapid growth in the subjects, in order as quickly as possible to screen out a disagreeable object.

1626. Where it is desirable to rear trees as quickly as possible on a high and exposed part, with the view of hiding some disagreeable object, it will be best to use the Scots and other hardy pines, and to plant them very thickly, so as to insure their drawing each other up as quickly as possible, observing to manure the land in order to encourage rapid growth at the outset.

SECTION XIX.—KINDS OF FOREST TREES WHICH MAY BE MOST PROFITABLY PLANTED IN ANY GIVEN DISTRICT OF THE COUNTRY.

1627. In raising timber as a profitable crop upon any landed property, two things require to be kept in view—namely, 1st, to plant those sorts of trees which will come to be of the greatest value in the market; and, 2d, to plant those sorts which are most likely to grow to useful size upon the soil to be planted. In illustration of this, we may suppose a proprietor desirous of planting hardwood, such as oak, ash, elm, and sycamore. If his ground was not naturally adapted for the healthy growth of these sorts, he would ultimately be a loser by planting them, even admitting that he could get a ready market for the timber. On the other hand, were the same proprietor to plant pines upon his land instead of hardwood, even although he could not get a ready market for such wood in his neighbourhood, he would (the land being adapted for pines) ultimately, from the healthy state of his trees, and the greater bulk of timber produced, be a great gainer by such culture. From this it will at once appear evident that, in order to receive the greatest possible value from timber in any given district, it is of the first importance to grow that sort of tree for which the soil and situation are adapted.

1628. In all districts near to any ship-building port, or to the principal stations of our railways, no wood can pay better than oak and larch, both of which are used in the construction of coasting vessels, and, indeed, in merchant vessels of every size. We have seen oak timber brought from a distance draw a higher price per foot than oak grown near the market, in consequence of superiority in the quality of the wood; and we have known proprietors, whose plantations were within a few miles of thriving seaports, say that their plantations of pine and larch paid them much better than their oak ones, their land not being so well adapted for the raising of oak as for pine and larch. We mention these facts to avoid misleading any; because the value of wood as a crop upon any piece of land—let the locality in which it is grown be what it may—does not so much depend upon the kinds of trees planted, as on whether the soil and situation are adapted to them. Hence we always advise the proprietor of land to plant those trees which his soil and situation are best fitted to bring to perfection. In the neighbourhood of all large towns there is a continual demand for Scots pine, larch, and spruce fir for railway purposes and for deals; and wherever the soil is adapted for the growth of these kinds of trees, they in general pay as well as, if not better than, any other sort of wood, seeing their growth is quick. Ash is a wood much in demand about all considerable towns for handle-wood and coach-building, &c., and pays any proprietor well when his land is adapted to the healthy growth of it—such as in dells, and other local hollows having a good strong loamy soil. The Scots elm is also much used in large towns, frequently for the same purpose as the ash; but unless it be grown in a loamy soil it will not prosper well, nor turn out a profitable tree to the planter.

1629. In the neighbourhood of all large towns a great quantity of wood is generally consumed in the form of fuel; and for this purpose many sorts of wood are used. Where coals are plentiful, wood is never grown for the purpose of being consumed as firewood, only the tops and larger branches of full-grown trees being sold for this purpose, along with the heavier timber when cut down. In England, however, and particularly in the counties where coal is scarce and high-priced, the raising of wood as a substitute for other fuel is necessarily resorted to, and constitutes a part of forestry. For this purpose there are large tracts of mixed coppice grown in the usual way for firewood—that is, this sort of coppice is planted in the usual form of a plantation, and enclosed with a proper fence. The trees which are intended to form the future coppice are generally planted at 4 feet apart, using none but such kinds of hardwood as are known to produce a great quantity of stools from the bottom or collar when cut over—such as the oak, ash, sycamore, hazel, willow, poplar, birch, &c. These trees, when first planted, are treated in the same manner as in the raising of hardwood for a timber plantation; but instead of thinning any out when they come to such a size as to stand close together—and that will be when the plants are from 15 to 20 feet high, and from 3 to 5 inches diameter in the stem—they are cut over to the surface, and allowed to push up another supply of shoots for another crop. In this manner these stools may be cut over for a supply of firewood for an indefinite number of years, and at intervals as may be found necessary in order to supply the demand. In cutting down these coppice plantations, the whole is not used for firewood, all the straight rods being used and sold for hop-poles, bobbin-wood for thread-manufacturers, hoops, crate and basket willows, poles for various purposes, besom-spray, implement-handles, &c.; and when the best of the wood has been picked out for these purposes, all the spray, and what may properly be termed refuse, is bundled up and sold in the form of fagots. In poor tracts, where the land is not suited to raise large timber, this sort of crop answers well, and indeed pays well, as also in low swampy grounds. But wherever land is of a fair quality, the more profitable system is to plant, at a given distance, hardwood trees, to be raised as timber of full size, and allow the thinnings to be used for firewood as they are cut out. By this mode of going to work, a greater weight of wood will be taken from an acre of land at the end of a specified time than if kept entirely under coppice, and consequently a greater return of profit would be received.

1630. In the districts in England where hops are grown, nothing pays better than the cultivation of small larches. These may be planted very closely together—say at from 18 to 24 inches apart—and drawn up quickly for hop-poles; and as the same land will produce several crops of the same sort, when planted in succession very profitable returns are made, and at very little expense; while, at the same time, in raising such a crop, little or no professional skill is necessary in the person who grows it.

1631. In districts where coal-mines abound, great quantities of wood of various kinds are in demand. There the demand for wood of all sorts to supply their different purposes is very great—more particularly for *propwood*, which is generally small thinnings of various sorts of wood, not less than 3 inches diameter at the small end. In the neighbourhood of coal-mines, the most profitable wood to plant is, first, larch, which, in a young state, when taken out as thinnings—say from 3 to 5 inches in diameter—is in great demand as propwood. When of a larger size—say about 8 inches diameter—it is much sought after for small sleepers to lay under the rails upon underground railways in mines; and when of full-grown size, the larch is used extensively as common railway sleepers, and as boards for various purposes. Second, Scots pine when of small size is also used for propwood; and when of full size, for sleepers and boards. Third, poplar and willow are much sought after about mines, particularly when of good large scantling, and are used in the form of plank for clothing the waggons. Fourth, ash is also much used in mining establishments, &c., for handles to picks. Fifth, elm is also a good deal used for shafts to the underground waggons. Sixth, oak is also in considerable demand in mining operations, and is used for framing for the large waggons, and for various other purposes connected with such establishments. The above are the principal sorts of wood used for mines; but the most important in such districts is small thinnings of wood of every kind, provided it be a size averaging from 3 to 5 inches in diameter—and for this class of wood-produce there is an increasing and unlimited demand.

1632. In the neighbourhood of flax-manufactories there is always a great demand for sycamore bobbins about 6 inches in diameter, as also of a smaller size, which are generally made of birch. For railway purposes vast quantities of wood are now used in the form of sleepers, for which larch and pine are used—and for these there is an unlimited demand; also in the form of posts and rails for the purpose of fencing the fields along the lines, for which larch and pine are also mostly used; and in the form of waggons of various kinds, for which purpose ash, elm, oak, pine, and fir are used. In the making of a line of railway, the contractors require a great quantity of wood from the different proprietors through whose grounds they pass in the act of working, and in cases of this nature a good price is generally given for it; but the sales of this description are only of a temporary nature, in so far as the contractor's work is to be calculated upon. When, however, a line of railway is opened up through any property, although it should be a considerable way off, the proprietor is, in respect of a market for his wood, or indeed of any other produce upon his estate, nearly on a level with his neighbours who may be within a comparatively short distance of the same market. In such circumstances, the proprietor may plant any crop that will best succeed upon his land, and calculate upon having it brought to market in a cheap, sure, and expeditious manner. In such a case, if the proprietor find his land adapted for growing the more valuable kinds of timber-trees, he need not be in any hesitation as to planting and rearing them, although he may not have a market near for their sale; because, when his wood is ready for cutting down, he can avoid the expensive process of horse-cartage, and put his trees at once upon the railway trucks; and at a very trifling expense he may have them conveyed 50 miles to market, and sold and delivered much quicker than his neighbour, who may have to cart his wood only 5 miles to the same place, although the trees may have been all cut at the same time. This we have seen frequently done.

1633. In conclusion upon this head, we have to state that every proprietor of land who intends to plant a portion of it with forest-trees, should not reason with himself merely as to what kinds of trees will sell best in his neighbourhood when grown. He should, on the contrary, also study the nature of his soil and situation, and plant those sort of trees upon it which will thrive best and arrive at the greatest state of perfection, let the kinds be what they will. If he do this, he will have the greatest possible bulk of timber from a given number of acres in a given number of years, and will realise the greatest sum of money as their value. But if he act in an opposite way, and plant trees not adapted to his soil and situation, he will without doubt spend his money in the first place uselessly, and the after-result will be vexation and disappointment.

SECTION XX.—MANNER OF PROCEEDING WITH PLANTING OPERATIONS.

1634. In all planting of young forest-trees, the superintendent of such operations should be a man who has had considerable practical experience in that line of work. Unless he has had such experience, and that rather upon an extensive scale, he will not be able to judge for himself in any extraordinary contingency. A man who is allowed to undertake planting operations without proper practical experience is generally put out of his way by every change of the weather, and then knows not how to proceed. In such extremities he seeks the advice of others, who very likely are as ignorant in the matter as he is himself; consequently, the mind of an inexperienced man is liable to give in to wrong advice, and then the whole work goes wrong—time is lost, the work is badly done, and, in the end, failure is the sure result. This state of things, we are aware, often happens in planting operations; therefore, for the guidance of those who may not have experience enough, we shall here lay down, in a particular manner, the way of proceeding with planting operations as they ought to be done.

1635. All the land intended for the growing of young forest-trees should be drained, and otherwise dealt with, preparative to planting, in all respects as has been explained in those sections which, in the foregoing part of this work, have reference to the subjects of draining and preparing land for planting, and which may be found suitable to the case—observing in particular to make sure that the drains have had sufficient time to act upon the land, and that pits for the larger-sized plants have been opened a sufficient length of time to insure the soil taken out of them being improved by the weather before commencing to plant, with any other precautions necessary, in order to secure complete success, as the case may require. Then, allowing that all the necessary preparations in the land have been strictly attended to, the person who is to take the management of the work will first consider the nature of the situation he is about to plant upon, which we shall suppose to be an extensive piece of moor-ground containing several varieties of soil. This being the case, he will next begin upon one side of the ground, and take observations as to the kinds and quantities of trees he will require for each particular part, supposing it naturally divided into thin heathy ground, with high exposure—good loamy soil, upon a slope—moss 2 feet deep, resting upon clay—deep moss, but well dried—strong clayey soil, upon a level—light sandy soil, resting upon rock—bare rocky parts, with here and there good dry loam. Supposing that the ground to be planted contains all the varieties of soil above mentioned, the manager of the work will consider as to the quantity of ground contained in each of the divisions; and having ascertained this, either by measurement or by the eye, according as he may find himself qualified, he will put up a *pin*, with a number upon it, in the centre of each district, and enter a corresponding number in his note-book, thus:—

1636. No. 1.—Twenty-seven imperial acres of thin heathy ground, to be planted with Scots pine and larch, one year transplanted, of each an equal number, and at 4 feet apart.

No. 2.—Ten acres of good loamy soil, upon a sheltered slope, to be planted with 100 oak and 202 ash to the acre, and made up to 4 feet with one-year transplanted larch and two-year transplanted Scots pines, of each an equal number.

No. 3.—Twelve acres of moss, 2 feet deep, resting upon clay, to be planted same as No. 2.

No. 4.—Twenty-four acres of deep moss, well dried, to be all planted with two-year transplanted Scots pine and spruce firs, at 4 feet apart, of each an equal number, excepting 3 acres in the centre, which cannot be well got dried, and which must be planted entirely with alders, at 4 feet apart.

No. 5.—Thirty acres of strong clayey loam, upon a level, to be planted with 300 oaks to the acre, and made up with equal numbers of two-year transplanted larch and Scots pines, to 4 feet apart over all.

No. 6.—Seventeen acres of light sandy soil, resting upon rock, to be planted with 150 beech, and 150 birch 18 inches high, to the acre, and made up to 4 feet over all with one-year transplanted larch and Scots pines, of each an equal number.

No. 7.—Forty-three acres of bare rocky ground, with here and there spots of good loamy soil to the extent of 6 acres in all; bare rocky ground to be planted with 8-inch birch, two-year seedling larch, and Scots pines, of each an equal number to the acre, making them stand 3½ feet plant from plant; good loamy soil to be planted with ash, at 12 feet apart, and made up with Scots pine and larch to 4 feet over all.

1637. Now, supposing that the person who is to take charge of the planting of such a piece of ground has gone over it, and marked very particularly in his note-book the different natures of the soil in it, and stated the kinds of plants that he considers will be most likely to do good upon it, as we have above stated, he will, when he goes home in the evening, sit down and draw up a statement as to the number of each kind of tree he will require to have brought forward for the planting of each of the districts as numbered. In order to assist him in this calculation, the following table will be found most useful. Indeed, such a table is not only useful to a young and inexperienced forester—it is as useful to a man of fifty years' experience as to one of five, because no forester can keep in his memory the number of plants he may require at a given distance per acre, nor can he at all times find it a convenient matter to calculate these numbers. In order, therefore, to save time, and to form a sort of ready-reckoner for the forester, we insert the following table:—

1638. TABLE showing the Number of Trees that can be Planted on an Acre, whether the Imperial, the Scottish, or the Irish Acre, from 1 foot to 30 feet distance Plant from Plant.

IMPERIAL ACRE.				SCOTTISH ACRE.				IRISH ACRE.			
Distance.	Number.	Distance.	Number.	Distance.	Number.	Distance.	Number.	Distance.	Number.	Distance.	Number.
1	43,560	12	302	1	54,760	12	380	1	70,560	12	490
1½	19,360	12½	270	1½	24,338	12½	350	1½	31,360	12½	452
2	10,890	13	257	2	13,690	13	324	2	17,640	13	417
2½	6,970	13½	239	2½	8,761	13½	300	2½	11,209	13½	385
3	4,840	14	222	3	6,084	14	279	3	7,840	14	360
3½	3,556	14½	207	3½	4,470	14½	260	3½	5,760	14½	335
4	2,722	15	193	4	3,422	15	243	4	4,410	15	316
4½	2,151	15½	181	4½	2,704	15½	228	4½	3,484	15½	292
5	1,742	16	170	5	2,190	16	214	5	2,822	16	275
5½	1,440	16½	164	5½	1,810	16½	201	5½	2,332	16½	260
6	1,210	17	150	6	1,521	17	189	6	1,960	17	244
6½	1,031	17½	142	6½	1,296	17½	178	6½	1,670	17½	234
7	889	18	134	7	1,117	18	169	7	1,440	18	217
7½	774	18½	127	7½	973	18½	160	7½	1,254	18½	206
8	680	19	120	8	855	19	151	8	1,102	19	195
8½	603	19½	114	8½	758	19½	143	8½	976	19½	185
9	537	20	108	9	675	20	137	9	871	20	176
9½	482	22	90	9½	606	22	113	9½	782	22	146
10	435	24	75	10	547	24	95	10	705	24	123
10½	395	26	64	10½	496	26	81	10½	640	26	105
11	360	28	55	11	452	28	70	11	583	28	90
11½	329	30	48	11½	414	30	60	11½	533	30	79

1639. Before proceeding further, it may be proper to give a slight explanation of the above table. If, for example, the forester wish to ascertain how many trees will be required to plant 1 imperial acre at 3 feet apart, he will first cast his eye to 3 in the left-hand line of figures, headed *distance*, and under imperial measure, from which figure he will next cast his eye to the right, and in the second line of figures, exactly opposite, he will find 4840, which is the number of plants required to plant an imperial acre at 3 feet plant from plant. If he wish to ascertain the number required for any other distance, he has only to go upon the same principle, always looking first for the distance required in the left-hand line of figures. If it is desired to know the number needed for a Scottish acre, let him look for the number under that measure instead of under imperial; and if for the Irish measure, it is only necessary to examine under that heading in the same way. Having given the table, we shall now point out the manner of drawing up the statement mentioned above.

1640. **STATEMENT** of the Numbers and Kinds of Young Trees required to Plant the different Districts in —— Plantation, upon the Estate of ——, 1880.

Districts.	Imperial acres in each.	Number and Kinds of Trees Required.								Total Number of Trees.
		Larch.	Scots Pines.	Spruce Fir.	Oak.	Ash.	Birch.	Beech.	Alder.	
1	27	36,747	36,747	...	...	...	...	...	...	73,494
2	10	12,100	12,100	...	1,000	2,020	...	...	...	27,220
3	12	14,530	14,530	...	1,200	2,424	...	...	...	32,684
4	24	...	28,581	28,581	...	...	...	...	8,166	65,328
5	30	36,330	36,330	...	9,000	...	...	...	...	81,660
6	17	22,087	22,087	...	...	...	2,550	2,550	...	49,274
7	43	52,023	52,023	...	...	1,812	43,857	...	...	149,715
	163	173,817	202,398	28,581	11,200	6,256	46,407	2,550	8,166	479,375

It may be necessary for me to give a little explanation of the above statement. In order to this, we will look over District 2. Upon looking back to particulars on the second district, as they were supposed to be taken upon the ground, it will be seen that it contains ten acres, which number is stated in the second column from the left hand in the above table. Next, it was to be planted with 100 oaks and 202 ash to the acre. Now, if we multiply these numbers by 10, for the number of acres, we will have 1000 oaks and 2020 ash for the whole district, which is stated, accordingly, under oak and ash upon the same line as formerly stated. Again, the particulars state that the ground was to be made up to 4 feet with one-year transplanted larches and two-year transplanted Scots pines, of each an equal number. Now, if we look at the table of distances formerly given, we shall find that, in order to plant one imperial acre with trees at 4 feet apart, 2722 are required; but as we have already allowed 302 hardwood to the acre, this quantity must be deducted from the 2722, consequently leaving 2420 nurses for the acre to be planted among the hardwood; and as the nurses are to be larch and Scots pines, of each an equal number per acre, we must take the half of the last number given for each sort—that is, 1210 of each for the acre. Now, there being ten acres of ground to plant in this instance, we must multiply the last number by 10, and the gross amount of each sort of nurses required will be 12,100, which will be found to correspond with the numbers stated under larch and Scots pines upon the line No. 2. In the same manner all the other districts are described; and in the summing up of the whole it will be at once seen that, in order to plant the whole 163 acres, the forester will require to bring forward to the ground 479,375 young trees, of the various kinds stated in their respective places.

1641. Presuming now that the person in charge of the work of planting has looked over the ground, and has put up a pin in the centre of each district to correspond with the number entered in his statement, and that he has drawn out such a statement as we have shown above for his future guidance in the work, he will next order the plants to be brought forward and *sheughed*, each district having the quantity of trees adapted for it put by themselves—that is, in order to plant No. 2 in the manner proposed, there will require to be sheughed in it 12,100 one-year transplanted larches, and the same number of two-year transplanted Scots pines, with 1000 oaks, and 2020 ash; and so with each of the others. Great care is requisite in bringing forward the young trees to see that it is done during open weather, and when there is a little moisture if possible; and if the plants are to be brought far from the nurseries, all their roots should be covered during the journey, to prevent the air from having any bad effect upon them. As soon as the cart arrives, a deep dry part of the ground must be chosen for sheughing or laying them in. This requires to be done in a very careful manner, avoiding too many hands being employed on the work at once. If those points are not strictly attended to, there will be a great chance of failure in the results of the work. We have frequently, when assistant-forester, seen shameful carelessness practised in regard to what we are now recommending; and this is the very reason that makes us so urgent in recommending carefulness where it is wished to have success in the work of planting. It may be remarked here, however, that the plants need not be all brought forward at one time, but only as many as may be wanted for planting one or two districts; as, were they all lifted at once and sheughed on the forest-land, they might, in the case of bad weather coming on, have to lie too long, and so get injured in the sheugh. Therefore, we have to explain that in the present instance we merely refer to the sheughing to show how it is dealt with.

1642. In sheughing the young trees, take out a trench deep enough to hold the roots easily, and put the turf and earth which is taken out of it all along upon that side of it which is meant to be the outside when the work is done. On having this earth levelled along the back or outside of the opening, if it is the hardwood trees you intend to put in first, you may do so without loosening the bundles (as we presume the plants will be tied up in bundles), as they are not apt to spoil although they lie a time in the ground in a crowded state; but if the plants are firs or pines, have the bundles opened out, and the plants spread out upon the side of the trench not more than 2 inches thick. When the whole length of the trench is filled with the plants, whether hardwood, pine, or larch, put the finest of the earth from the next trench on their roots, and make up above that with a sufficient quantity of soil to cover the roots of all the plants laid in, as well as to make another sufficient opening for another row. When the roots are thus sufficiently covered, give the whole a gentle tramping, in order to keep out frosty winds the more securely. Then, immediately after this tramping, gather up in your spade any fine earth in the bottom of the trench which is to receive the next row, and fill up with it any open parts about the necks of the plants in the line put in, in order that no spaces may be left for the air to get down to the roots. After re-levelling the surface of fresh earth which is put above the roots, the front of the new trench may be lined off, and filled up as before. Many planters are very careless about this part of the work, and sheugh in the plants in a mere temporary manner; but we would caution every forester who wishes to excel in the work of planting against such a manner of procedure, and urge him in all cases to put his plants into the earth in a manner as permanent as if he knew they were to remain for months. We have ourselves seen young trees sheughed in a temporary manner, the planter supposing that they would be all planted out in the ground in their places in the course of a day or two; but, instead of this expectation of his being realised, frost set in, and snow followed. The trees lay in the sheugh in the same temporary state they had been put in at least two months. When the weather broke up, the forester who had the management of the work persisted in planting them, and, as we anticipated, a large proportion of them died. We mention this here in order that others, being aware of the fact, may in future guard against such a manner of going to work, which is not only discreditable to any forester, but, what is worse, ruinous to the proprietor. In the same manner as we have described for the securing of the trees in No. 2, let the trees belonging to the other districts be done also, care being in all cases taken to have them sheughed in a piece of dry soil.

1643. The young trees being all brought forward and sheughed in their respective places, the superintendent of operations will next consider as to the number of men he may require for executing the work. In this case he had better select a few good hands, and have the work done properly, than gather together a number of bad ones, who perhaps never had planted a tree before, and who may very likely be regardless how the work may be done, provided they receive their daily wages. As to the number of men that will be required to do the work in a given time, we shall suppose that the planting is to be commenced about the 1st of February, and that the forester, on account of having other plantations to make the same season, is anxious to have the plantation in question—that is, the 163 acres referred to above—finished in the course of four weeks. There are thus 163 acres to be planted in four weeks; and as at that season of year it is more than likely that a portion of the time will be broken upon by bad weather, therefore, in order to have the work finished if possible by the time specified, instead of calculating that it is to be done in twenty-four days, we must deduct a portion, and say that the work is to be done in eighteen days. We have thus 479,375 plants to put into the ground in eighteen days. By the system of notching, we generally calculate that a man in a short winter day, working from eight in the morning to four in the afternoon, and allowing one hour for rest, should plant one thousand young trees with ease, and at the same time do his work well. Let it be understood, that if a man is much hurried at his work, he cannot do it well: the superintendent should, therefore, keep in view not to hurry his men unreasonably, but to make them give a fair conscientious day's work—as, by so doing, he will have his work much better done than if he acted otherwise. As this work is to be done in the month of February, when the men, instead of working from eight to four, can work from seven to five, they will be able, with the assistance of a boy each, to plant 1300 plants each.[1] Now, if we divide 479,375, the number of trees to be planted, by 1300, the number that a man can plant in a day, we will find that, in order to plant the whole with one man, he would require about 369 days; but if we employ twenty men, they will, at the rate of 1300 a-day each, plant altogether, in one day, 26,000 trees; and if we divide 479,375, the number of trees to be planted in all, we will find the answer to be eighteen and a half days nearly; therefore, in order to finish the work in about eighteen days, twenty men will be required to plant at once. As, however, the planting of the hardwoods in the pits will take more time than the others, it is necessary to calculate upon them as extra, even allowing that we have already included the number of hardwoods among the other trees. By looking at the statement containing the number of trees to be planted, it will be seen that there are of hardwoods, together with larch, pine, and fir, two years transplanted, about 187,174 plants in all, which require to be planted in pits. Now, in order to plant these in eighteen days, we must calculate thus: One man will, in a moderate state of soil, plant about 500 such trees in pits in one day, and at this rate other twenty men will be required to plant the hardwood and two-year transplanted coniferous trees in the same time that the twenty men will plant the others, which have to be notched; consequently, in order to have the whole work done in eighteen days, forty men will require to be employed. The superintendent, after making a calculation of this nature, should, when the men begin work, keep a note of the number of the trees planted upon the first day, and compare the work actually done with his calculation. By doing so, he will be aware of how far he is likely to be correct in his plans in the future management of the work, and will be able to regulate it accordingly within the time he is confined to.

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[1] In stating that the men will be able to plant 1300 young trees each per day, it is to be understood that they are all experienced in the work. If they are not so, and have to be taught on the ground, they may not plant over half the number stated for each day.

1644. We shall now suppose that the superintendent has forty men looked out in order to commence work, and has given them orders to meet him on the ground at a certain time, and that he intends to commence by planting No. 1, being twenty-seven acres of thin heathy soil, not adapted for the growing of hardwood, to be planted with Scots pine and larch, 4 feet apart, one year transplanted, of each sort an equal number. We shall further suppose that the superintendent is forward on the ground on the morning appointed before any of his men are collected, which ought always to be the case; for if he be a man of an indolent habit in the morning, the men will very likely prove the same, and consequently the work will not go on in a prosperous manner, and there will be small hopes of getting through it in time.

1645. Being then thus forward, he will arrange in his own mind quietly as to the work to be done for the day. If it have the appearance of being a fine one, he will put the men to plant upon the most exposed parts of the grounds; and if otherwise, upon the most sheltered parts. The superintendent should provide himself with three or four poles, such as farmers generally use for straightening and measuring off their furrows, and while the men are collecting, and before it is light enough for them to plant with propriety, he will begin upon one side of the ground to be planted for the day, and pace off, from the side at which it is intended to begin, the proper breadth for the men to be employed upon. At the end of that distance from the outside, he will put up one of his poles as a guide for the innermost man to keep by in the act of planting; and in the same manner he will mark off the whole length of the ground by one or two more poles before the men commence.

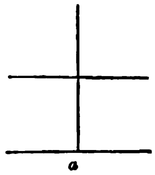
The poles being set to the breadth required, he will next see that each of his men has provided himself with a stout boy or a girl for handing the young trees, and that each of these has brought a strong apron for holding them, in order to protect their roots from the wind, as well as to keep them together while he takes out one at a time with his right hand. Being satisfied of this, he will next examine the sort of spades the men have brought to work with. So far as our experience has enabled us to judge, there is, for the purpose of notching, no implement so useful as a half-worn common garden-spade; and for this purpose we always prefer one with the blade from 8 to 9 inches in length. In all notching of trees, therefore, we make every man bring along with him such a spade as we have described, never allowing any man to plant with a new one, as we have found from experience that the man who uses a new one cannot plant the trees nearly so well, nor can he plant nearly so many in a day, as he would do with a half-worn, sharp-edged spade. However, those who may not be satisfied with using old spades as we are in the habit of doing, will find an excellent article, made for the purpose of planting young forest-trees, in any nurseryman's warehouse. These are termed *planting spades.* They are of the same form as a common garden-spade, but smaller in the blade, and having the *shears*, or that iron part which clasps the wooden handle, made stronger than in the common garden-spade, in order to resist the more certainly the strong pressure which is sometimes put upon the handle in the act of notching upon the tough turf.

1646. The superintendent being perfectly satisfied as to the good state of all the things above mentioned, he will cause some old trustworthy man to take charge of the plants that have been sheughed, whose duty it will be to give out to the boys the different sorts of young trees as they require them. This must not be trusted to the boys themselves, as they would most likely remove the earth from the roots of the plants when they came to take away a quantity;

and, besides, they could not judge as to the quantity required to be taken at one time. Having appointed an old man for this purpose, the superintendent will send the boys to him to where the plants are, and cause them to bring with them in their aprons, each, as nearly as possible, fifty larch and fifty Scots pine, with their roots laid inwards—that is, the old man will take fifty plants of larch and place them in the boy's apron, say upon the left side, with their tops out and their roots inwards, and he will also take fifty Scots pine and place them in the same apron upon the right side in the same position. This precaution is necessary, in order to protect the roots from the winds and drought. It is not necessary that the man should count every plant he puts out; but if he count a few times, he will very soon, from practice, be able to give the boys the desired number, always observing in the present case to give larch and Scots pine of each an equal number. This he will do every time the boys come to him for a supply as their former quantity is done: fifty plants of each at once make a very good quantity.

1647. The men, with each a young person and plants, being all arranged in a line upon the edge of the ground to be planted, having their backs towards the plantation-ground, and their faces looking upon the fence or boundary from which they are to start, and each having his given breadth to plant, the superintendent will, with his own hands, take a spade and show them how he wishes the trees to be planted, and also the manner of keeping the distances of one tree from another; at the same time he will show the boys how to put the tree into the notch as it is opened by the man. We may here explain the manner of planting by the system of notching, and how the boys ought to put in the plants. The operator, with his spade, makes two deep cuts upon the turf, crossing at right angles exactly where the plant is to be put in. (See fig. 143.) He next inserts his spade across one of the ends of the four rays, as at *a*, which may be about 5 or 6 inches from the centre—this insertion of the spade being made on the side next himself. When the spade is inserted at *a*, he bends the handle or head of the spade towards himself, and nearly to the ground. At this stage of the operation the turf will open in the centre of the cross in four equal parts, but most from the point *a*; and at this instant the boy inserts his plant at the point *a*, where the spade intersects the ray from the centre. Immediately on inserting the plant he will draw it to the centre, while the planter will retain his spade for a moment until the boy has the roots rightly adjusted after passing them through the cut. As soon as this is done, the operator raises up the handle of his spade, letting the earth

Fig. 143.



and turf down upon the roots of the plant, and makes all the cuts close and compact about it by tramping with the forefoot first, and then with the heel. If the cuts do not close tightly, as is sometimes the case when the turf is of a hard benty nature, a little piece of thin turf may be taken from the open space and placed over the cut, which will keep out the drought, this also getting a tramp with the foot. When the situation to be planted by notching is upon a sloping brae, the operator should stand with his back up the hill and his face looking down. By doing so, he inserts his spade for the opening of the turf at right angles with the rise of the ground upon the upper side; and in this case the water coming along the surface is intercepted by the cuts, and retained for the advantage of the young trees. Another point to attend to in the planting of young trees by notching is to see that they are not inserted too deeply, for this is an error in planting which very often takes place. In order to avoid this, which is against the health of the plants, the boy should be instructed to hold the young tree between his fore-finger and thumb, just about one inch above where the earth has been formerly. When he puts it into the cut, he should hold it firmly by that part until the turf falls down into its place; and if he finds that the turf, when down, is much above the points of his finger and thumb, he must pull it up a little, so as to have these resting upon the surface of the turf. By attending to this precaution, the young trees will have a better chance to succeed well. We have frequently seen the boys left to make the plants firm in their place, but this should never be allowed by any man who wishes to do anything like his duty to his employer. We have also known foresters who were so stupid and foolish as to make the men and boys hurry on and get the plants put into the ground at all events, not paying the least attention as to the manner in which the work was done, boasting then to their employers as to how many plants they had put in in one day, and of the low price at which they could plant an acre of ground—and all this with the view of deceiving their employer and gaining his favour in the meantime. But, as was the natural result, the crop was to a considerable extent a failure. Every forester who wishes to do well to himself, and to his employer at the same time, should have his planting work executed well, without paying respect to a few extra shillings of outlay on the acre. The work, when well done, will prove satisfactory to the proprietor afterwards, as well as to himself; and we again urge the making every man employed on the work of planting accountable for the planting of the trees in a proper manner, and not the boys.

1648. The superintendent will now see that his men go on according to the instructions given them, which are in the meantime supposed to be as above; while he also takes care that they cause the boys to mix the larch and Scots pine equally upon the ground—that is to say, that the boys put in one larch and one Scots pine alternately, mixing them in equal numbers as nearly as possible, and as near to the given distance as can be guessed—that is, in the present instance, *four feet.*

1649. The men now, as we will suppose, going on briskly with their work, the superintendent will keep a sharp look-out behind them, to see that they do the work according to his directions given to them when they commenced. If there be any hands among them who are more stupid than others, he will look more sharply after them, and leave more to themselves those whom he knows to be well acquainted with the work. He must go backwards and forwards among the planters, minutely examining their work; in short, he must examine almost each tree as it is put into the ground, and see that it is properly planted and made firm in the ground. When the least fault is observable, it ought to be checked at once, and the fault laid to the person who did it; and if he persist in doing the same thing over again, the better way is to pay him off at once rather than run the risk of having the work badly done. An example will thus be made among the men, showing them that the orders of the superintendent must not be trifled with. Every cut made with the spade in the act of planting a tree should be firmly closed, in order to prevent the drought from taking effect upon the roots.

1650. When any boy has his supply of plants nearly finished—say all but ten of each sort—he will give these to the man whose assistant he is, and run for a fresh supply while the man is planting them. By this method no time is lost; and as the supply of plants is generally not far off, and the old man ready to give them out, any boy may be back with a fresh supply before the man has twenty planted. Some planters have one boy serving the others with plants, but this method we have found objectionable, seeing the plants are more exposed by it.

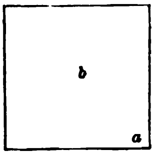
1651. When the planters have arrived at the other end of the ground laid off for them by the poles, the superintendent will, from the pole at which they ended, measure off another space of the same description as the first, and cause the men to fall in upon it, and plant backwards another breadth of land, ending at where they commenced. In order that the men may not be hindered, the superintendent should have the land measured off previous to their finishing the first piece, and make the pole at which the men end the last to be removed, and the first to begin at again. By going to work in this manner, the superintendent is on the spot to see his men fall into their proper places again upon the new land;

and thus the planters will cross and recross the ground until they have the district finished. When there may be any odd corners to finish, upon which the whole number of men could not be profitably employed at once, the superintendent should cause a few of his most trustworthy hands to finish them, and carry off the others himself to commence upon another district.

1652. At any time when the day may turn out wet, if the men have all collected, and are willing to work, let them do so, but only as long as the ground is not saturated with rain, which can at once be known by the young trees not firming in the ground. As soon as the superintendent sees that the men cannot, with the usual beating, firm the trees, let him give orders to drop work at once: to persevere in such a state of things is the worst management. However, upon dry ground this will seldom occur.

1653. We shall now suppose that the planting of district No. 1 has been finished, and that the superintendent wishes to go on with the next district in succession, No. 2. This consists of ten acres of good loam upon a sheltered slope, and is to be planted with 100 oaks and 202 ash to the imperial acre, and to be made up with one-year transplanted larches and two-year transplanted Scots pine, to the distance of 4 feet over all. Here it is understood that the pits have been all made for the hardwood and Scots pine a considerable time previous to commencing to plant; and we shall now suppose that it is intended to plant these in the first place, beginning with the hardwood kinds. In planting the hardwood in the pits, the boys will not be able to carry about with them so many plants as they did of the pines and larch, the hardwood plants being larger—twenty-five of oak, and the same of ash, will, in the present case, be a fair proportion, and enough of trees at once.[1] In the act of planting in the pits, if the situation be an exposed one, we put the plant, not in the centre of the pit, as many do, but in one corner of it. (Fig. 144, *a*.) Our object for doing so is to obviate the bad effects arising from the wind shaking young trees when first put in their place, as in exposed sites this is greatly prevented by planting the tree in the corner of the pit rather than in the centre. In the former position the young plant has two firm sides to rest upon instead of the open soil all around it, as is the case when planted in the centre, as at *b*. As to this, the superintendent must judge for himself, whether he ought to plant the one way or the other, and be regulated, in doing so, according as the

Fig. 144.



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[1] In the case of planting the above mixture of oak and ash, the oak should be first put in at 24 feet apart, and the ash between them to 12 feet alternately.

trees are apt to be shaken or not by severe storms. Whatever way, however, may be resolved on, the boy holds the tree in its place until the man with his spade fills in all the loose earth taken out of the pit—the boy all the time moving the plant slightly up and down until he finds the earth heavy about its roots. When the whole earth is in, the man should take hold of the plant, and judge if it is too deep: if so, he should pull it up a little, and then with his feet make the soil firm about the roots of the newly inserted plant. As it is understood that in the making of the pits the turf, when taken off, was divided into two equal parts, the man will next take the divided turf and place it, grass undermost, upon the surface of the pit, with the tree in the centre, and make it quite firm and close about the plant. The earth upon it should then be pared off, and put with care upon the joining all round, the whole receiving a firm beating from the feet. In the same manner proceed with the planting of all the trees in the pits, both the hardwood and the two-year transplanted pines.

1654. The hardwood and pines being all planted in the district No. 2, the superintendent will next proceed to have the ground filled up, to the distance formerly specified, with the larch portion of the nurses, by the method of notching already described. District No. 3, containing twelve acres of moss resting upon clay, is to be dealt with in the same manner as the district last referred to. We have seen excellent oak timber upon a mossy surface-soil resting upon clay, and that was when the moss had been well dried from superfluous moisture. When it is well drained, the moss has a rapid tendency to subside, and the roots soon find their way down into the clay, where they derive their principal nourishment. Indeed, upon a soil of this description, larch and Scots pine thrive well also.

1655. District No. 4, being twenty-four acres of deep moss, but well dried by draining, will not grow hardwood to any advantage, unless, indeed, we may except ash, which will do well in moss as a coppice. In this case, however, we have advised to plant spruce fir and Scots pines, both thriving pretty well in a mossy soil: the spruce firs more particularly do well upon such a soil if the situation be at all sheltered. These should all be planted by pitting, as the plants used are large, and the surface supposed to be rough with strong grass; and particular care should be had to see that they are made firm. In a mossy soil, plants of any description never come away quickly. We have observed mossy tracts that had been planted in new plantations make very little progress for the first few years from the time of planting. This was occasioned by the want of stimulus in the soil to set them off in their growth, the moss being always what foresters term *dull;* but as soon as shelter is produced by other trees growing around the moss-ground, the plants in it come away rapidly. In the centre of No. 4 there is a spot of three acres, which, from the difficulty of getting conveniently a sufficient fall for the water, is not well drained. In such a place the alder is the only crop which will succeed, and these should be planted by pitting.

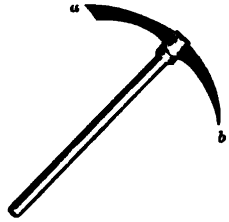
1656. District No. 5, being thirty acres of strong clay loam upon a level, is excellently adapted for the growing of hardwood, and more particularly of oak; therefore we have recommended to plant 300 of them to the acre, and make up to 4 feet over all with two-year transplanted larch and Scots pine, of each an equal number. In this case, the oaks being upon a level part of the ground, and sheltered by rising ground in the neighbourhood, the plants may be inserted in the centres of the pits, and the larches and Scots pine, which here, on account of the strong herbage upon the ground, are to be two-year transplanted, will, in order to have justice done them, require to be planted in small pits merely the breadth of the spade on the side of the square, taking care to make them firm in the ground, and not to put them in too deep—an evil with regard to coniferous trees of all kinds which should be particularly guarded against. The roots of all these trees, if buried out of the influence of the air, are sure to be thrown into bad health, or perhaps die, according to the degree of depth.

1657. District No. 6, being seventeen acres of light sandy soil, with thin surface-turf, and resting upon rock, is to be planted with 150 beech and 150 birch to the acre, each sort 18 inches high. These must be put into pits; but the soil being of an open free nature, these need not be large. Pits of the same size as has already been recommended for the larch and pine in the last district, will answer perfectly well; and allowing 300 hardwood to the acre, the pits for them will require to be made about 12 feet apart. These being put in, the ground is to be made up to 4 feet over all with one-year transplanted larch, and one-year transplanted Scots pine, of each an equal number. They may all be notched; and in putting them in, care should be taken to see that they are properly mixed, and larch planted next the hardwood.

1658. District No. 7 consists of forty-three acres of bare rocky ground, with here and there spots of good loamy soil, to the extent of about six acres in all—the bare rocky ground to be planted with 8-inch birch, two-year seedling larch, and two-year seedling Scots pine, of each an equal number to the acre, making them stand 3½ feet plant from plant; the good loamy soil to be planted with ash, 12 feet apart, and made up with larch and Scots pine to 4 feet over all.

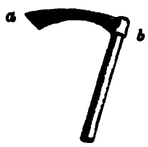
In this case have first the six acres of good loamy soil made up with the desired number of trees to the acre, planting the whole of them in pits.

Fig. 145.



In planting the bare rocky parts with the two-year seedling larch and Scots pine, and also the birch, a system of planting different from what we have yet mentioned must be resorted to—namely, that of planting by means of the planting-mattock. (See fig. 145.) The handle of this instrument is generally made about 36 inches long, and of a piece of good ash-wood: the mouth or cutting end, *a*, is about 4½ inches broad, and pretty sharp; and the length of the one side, from the face to the eye, is about 12 inches. The other side, instead of being broad and sharp, is made to taper to a point, as in the common pick (see *b*). In using this implement for the purpose of planting, which is only done upon thin, stony, or rocky ground, where the spade could not be used to advantage, the operator takes it into his hand in the same manner as he would do a common pick, and first pares off a thin part of the turf with the broad end *a*, exactly on the spot where he intends to plant a tree. Having this turf taken off—say about 6 inches square—he next with the pick-end loosens the soil in the spot pared to the depth of about 8 inches, bringing up at the same time to the surface any considerable-sized stone or stones that might interfere with the planting of the tree. In this manner any number of men may be employed, always observing to keep to the specified distance as nearly as circumstances will permit. In general, every two men employed with the planting-mattock are followed by one person having the trees in an apron, which he plants in the spots prepared. In planting with small seedlings, he uses an implement called the *planting-hoe*, represented by fig. 146. The iron part of this implement, from *a* to *b*, is generally about 9 inches long; the mouth or sharp end at *a* is made about 4 inches broad, and is not kept so sharp as the mouth of the mattock, it having to be used in the earth; the handle may be about 15 inches long. The person who is intrusted with the planting of the seedlings in the spots previously prepared by the men with the mattocks, carries his plants in an apron before him. In using the planting-hoe, he keeps it in his right hand, and digs it into each spot; and by pulling it, when in, a little towards himself, he makes a sufficient opening at the back of it to hold the roots of the young tree, which he puts in with his left hand, inserting the roots very carefully. As soon as the roots are properly put in, he withdraws the instrument, taking care at the

Fig. 146.



same time not to disturb the plant in its position. When the implement is out, he gives the earth, upon the side of the hole next to him, a push with its mouth, in order to hurl the loose earth into the hole about the roots of the newly inserted plant; and finishes by tramping and making the plant firm in its place. In this manner three men will plant 2000 plants a-day.

1659. On very bare or rocky surfaces, it is not always possible to get as much earth in a certain spot as will properly cover the roots of small seedling plants. Where this is the case, it is a better plan to sow the seed of the trees wished to grow in the ground at once, which is the only way of getting young trees to rise in certain districts. This plan has been adopted in some parts of the West Highlands of Scotland, and has been attended with good success.

1660. We often see seedling trees, of almost every common variety, growing upon old walls, or in any chink of a stone where the seed has only got a small portion of lime rubbish or other decomposed matter to vegetate in; and in this position we have seen them attain considerable dimensions—so much so, as to rend the wall, in which they had got a footing, into pieces. Even in the crevices of rocks we often see trees of very large dimensions growing, which points out that, where a young tree can only obtain a very slight footing for fixing its roots, it will prosper ultimately, and make room for itself. We are strongly of opinion that many bare rocky parts of a country might, under proper management in growing the seeds of forest-trees upon them, be made very productive and valuable, not only as a shelter to the surrounding country, but as yielding a profitable crop of timber. The oak and birch, in particular, are well adapted for this purpose. We have ourselves cut oak and birch coppice of valuable quality growing upon bare rock; and we are convinced, from what we have seen upon this point, that both these trees are well adapted for covering bare rocky ground;—the oak in moderately exposed, and birch in high and exposed, parts of the country. In sowing the seeds of either of these trees upon a bare rocky surface, it is necessary to have little patches prepared; and this can very easily be done by carting several loads of earth to where that does not previously exist in sufficient quantity. The acorns may be laid two or three in a shallow fissure of the stony ground, and merely covered by one spadeful of earth; and the birch seed may be sown upon the surface of a spadeful of earth laid down for the purpose, and merely get a slight beat with the back of the spade, in order to prevent them being blown away. Even Scots pine and larch seed may be sown in the same manner, but the oak and birch, being trees adapted for coppice-wood, are decidedly preferable for ground of the nature in question. Another reason for sowing the seeds of trees in poor, thin, rocky soil is, that there the seed is not very apt to be destroyed by mice, birds, and other vermin, they being in the habit of frequenting more favoured spots for the sake of cover and shelter.

In growing trees from the seed in such situations as that referred to, it is necessary to keep the patches clear from weeds for the first two years, and to thin out all the patches to one individual after the second year of their growth, at which stage the plants will be established in their place, and require no further attention.

Having now stated pretty fully the method of proceeding with planting operations, we shall conclude with a few general observations.

1661. In the planting of coniferous sorts among hardwood, it is of importance that the larch plants should as much as possible be kept next the hardwood. By this method of procedure, when the first course of thinning takes place, we shall have larch trees to sell instead of pines, which would not be the case were the pines planted next the hardwood; for in the first course of thinning it is always necessary to relieve the hardwood first by taking a few trees off them.

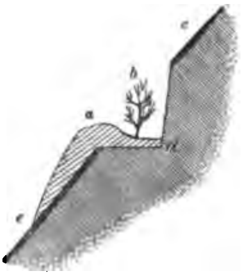
1662. It is now a well-ascertained fact among the more observing and intelligent foresters that in the culture of trees, as well as in the culture of any agricultural or horticultural plant, a change of crop, or a rotation of cropping, is necessary upon the land; and in many instances where this has not been attended to, a failure has been the result. However, there are modifications as to the extent of the failure in cases of this nature—this depending upon the adaptation of the land to the nature of the trees cultivated. For example, if a piece of land upon which pines or firs have been grown to full size be of a rather deep sandy loam, another crop of the same species may be taken, and the trees of the second crop may very likely prove as good as those of the first. But if a piece of land upon which these trees have been grown to full size be naturally thin in the upper stratum, with a hard tilly subsoil, the second crop will not succeed so well; while, on the other hand, from the upper stratum having been greatly enriched by the fall of their foliage, the hardwood trees would succeed; and after they had got themselves established in the upper soil, and had gained strength, they would send down their roots deep into the subsoil, and improve it to a great extent, especially after thorough drainage. After the hardwood crop had been perfected and cut down, and the soil in the upper surface had been improved by the foliage of the hardwood rotting upon it, a crop of pines would thrive well upon it again, and in all probability would be much better than the first crop; because, the soil being now much deeper than at first, and improved by the penetration of the roots of the hardwood, the roots of the pines would have a renewed soil to grow in—the one crop thus preparing the soil for the reception of the other, as is well known to be the case in all agricultural rotations of cropping.

1663. But although firs and pines will not grow to the same state of perfection when planted successively upon the same piece of land, excepting always those grown on soils of the granite formation, on which there seems to be no limit to their successive crops, they will, notwithstanding, grow to a considerable size, and even to the extent of becoming useful timber ultimately. Of this we take advantage in the planting of nurses among hardwood trees planted after firs and pines.

1664. In planting trees in pits, the planters should always be very careful to see that the best portion of the soil is put next the roots of the plants; for if this be not attended to, the success will not be equal to expectation. They should also bear particularly in mind to chop down and pulverise with the spade all soil which is put next the roots; for if put in about them in lumps, vacuities will be left, which will probably cause water to lodge there; whereas, when the soil is made firm and small, it gets in about the tender roots, nursing them kindly, and preventing superfluous moisture from lodging near them.

1665. Where pitting is performed upon a sloping piece of ground, such as the side of a hill, the earth, as it is taken out of the pit, should be put to the under side, and close upon the edge; and when the trees are planted in these pits, the good soil upon the upper edge of the pit should be broken well down with the spade, and put in about the roots of the young trees, leaving all the soil which was taken out of the pit still lying upon the under side, in order the better to protect the roots from drought and retain moisture about them; forming, when the tree is planted, a bowl in which a little moisture can be retained in its descent down the hill. Fig. 147 will explain the nature of this sort of pitting: *a* represents the earth taken out of the pit; *b* the tree standing in the pit, which has been filled up with earth by reducing the bank behind as at *d*, the original slope of the ground being indicated by the line from *c* to *e*.

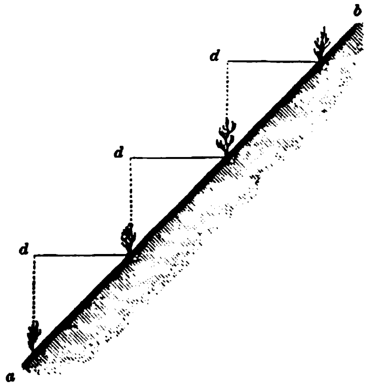
Fig. 147.



1666. Although the spruce fir does not naturally grow in this country, when planted in a high exposed situation it will do well, and even grow to useful size in a plantation upon an exposed part, if it be but sheltered by other trees of a more hardy constitution, such as the Scots pine and larch. Every planter, therefore, who wishes to produce a variety of trees in any high part of the country, if he will plant spruce firs in the interior where they will ultimately be well sheltered, may depend upon raising spruce fir timber of good and useful size—that is to say, if the soil be not too light, and of a dry gravelly and retentive nature.

1667. In planting trees in ravines and steep hollow parts, the operator should not measure his distance between the trees with the slope of the ground, but in the manner as represented in fig. 148, which is drawn to the scale of an eighth of an inch to a foot. The line *a b* represents a sloping bank to be planted with forest-trees at 4 feet apart; the places of which are shown in the figure at *c, c, c, c.* By measuring upon the line *a b* with an eighth of an inch scale, it will be at once seen that the distance between each tree from *c* to *c* is 6 feet; and had the planter planted his trees measuring his distance of 4 feet along the slope, he would, when the trees grew up, have had them growing at about 2½ feet instead of 4. In taking distances for planting trees in a case of this nature, the operator must always keep his *measure-stick,* if he use one, in the position pointed out in the figure by the line from *c* to *d*; or, in other words, he must, when taking a measurement for planting another tree, set the one end of his measure-stick at the bottom of the last tree planted, and keeping it level, let fall a perpendicular from the other end for the place where the next tree is to be planted, as shown by the dotted line from *d* to *c.*

Fig. 148.



SECTION XXI—EXPENSE OF LAYING DOWN LAND UNDER PLANTATIONS.

1668. In calculating the expenses likely to be incurred in the laying down of a piece of land under a crop of young forest-trees, the proprietor has to consider, first, the nature of the figure in which he may intend to lay out his plantation. On the form or figure of a plantation much of the expense of fencing it depends; and as this item forms a very considerable proportion of the entire cost, it will be proper here to show the circumstances which, when attended to, lessen this expense.

1669. When a proprietor intends to plant a piece of land upon his estate, say to the extent of 50 acres, he cannot exactly calculate the sum that would be required for the fencing of it until he has laid out and actually measured the line of plantation, unless, indeed, he shall fix upon a regular-sided figure. In order to illustrate the truth of this, we shall here give an example: To lay out a plantation of 50 acres in extent in the form of strips of 4 chains or 88 yards broad, the proprietor would require to erect 5676 lineal yards of fence to enclose it; and supposing the fence used in the enclosing of this plantation in the form of strips to be stone dyke, costing 1s. 6d. per yard, then the whole expenses of fencing, in this instance, would amount to £425, 14s.—equal to £8, 10s. 3d. per imperial acre upon the land enclosed.

1670. Again, supposing that, instead of laying out the 50 acres in the form of strips, the proprietor wished to lay out the same quantity of land in the form of a regular square, then the side of a square that would contain 50 acres will be 490 yards; consequently the four sides added together will amount to 1960 lineal yards, which would be the extent of fencing required, instead of 5676 as in the first instance, although the same quantity of ground is enclosed in both cases. Supposing, as before, the 1960 yards to be stone dyke, at 1s. 6d. per yard, the whole expense of fencing the square 50 acres would be only £147—equal to £2, 17s. 9d. upon each acre of the land enclosed. Now, this at once points out to proprietors of land the great utility of planting all plantations in a solid compact form, in order to prevent a large original outlay. By the cheaper method a much more valuable plantation is raised, apart from any other consideration.

The above examples point out the impossibility of giving anything like a just rule whereby the expenses of fencing ground for a new plantation can be ascertained, as these in all cases must be influenced by the form in which the ground is laid out. We shall, however, give two examples, as under:—

1671. For small plantations on home ground with hardwood, enclosed by wire fence 4 feet high:—

To medium expenses of fencing, per acre, with wire fence, 76 yards at 1s. 6d.,	£5	14	0
To 100 yards of open drains, at 2d. per yard,	0	16	8
To 1800 pits, at 1s. per 100,	0	18	0
To 200 hardwood trees, at 30s. per 1000,	0	6	0
To 1600 larch, at 20s. per 1000,	1	12	0
To four days of a man planting an acre, at 3s.,	0	12	0
	£9	18	8

1672. For an enclosure of 500 acres of moor ground with pines and larch enclosed by wire fence:—

To medium expenses of fencing, per acre, with wire fence, 20 yards at 1s., ...	£1	0	0
To 100 yards of drains, at 2d. per yard, ...	0	16	8
To 1200 pines, at 5s. per 1000, ...	0	6	0
To 1200 larch, at 10s. per 1000, ...	0	12	0
To three days planting, at 3s., ...	0	9	0
	£3	3	8

The first example contains the highest cost per acre that we ever found necessary for making of hardwood plantations, and the second contains the lowest that we ever could get a plantation of the kind done properly for.

1673. When plantations are made of small extent, the expense of fencing, as we have already stated, comes to a very high figure on the acre, as is shown in the case of the first example; while the larger they are made the less it is per acre, as shown in the second example, in which the entire cost on the acre for fencing is only 20s. We may state further, that in planting in some mountainous parts of the country, where the enclosures are made very large, the expense of fencing is indeed very small per acre, as in some such cases we have enclosures the expense of fencing which did not cost over 5s. per acre. On this branch of the work, therefore, as is to be seen from these examples, much of the expense of planting depends, this being regulated by the size of the enclosure.

1674. It is worthy of notice here that the expense of planting the enclosures is not much as a rule—that being, in the first example given, £3, 8s. per acre, while in the second example it is only £1, 7s.; thus showing that the greater part of the expense of laying down land under plantations is for fencing and draining the enclosures.

SECTION XXII.—THE KEEPING OF TREES IN A YOUNG PLANTATION CLEAR FROM GRASS AND WEEDS.

1675. Any piece of land having been planted with young forest-trees, in order to preserve them in a healthy growing state it is necessary to have them kept clear of all long grass, as well as any other weeds that might have a tendency to injure them by overtopping and crushing them down. The forester, then, should keep a sharp look-out during the summer season, particularly the first one after the young trees have been planted; and wherever it is observed that the grass or natural herbage, whatever its description may be, is likely to become strong, and to keep down the young trees, a careful man, with a few women and boys under his superintendence, should be sent over the different young plantations, who, with common shearing sickles, should be made to switch away all grass, &c., from every young tree that may require this to be done.

1676. This work must be carefully done, particularly where boys or other young people are employed, as they are very apt to cut off the tops of many of the young trees if they are not strictly looked after; therefore the man who is put over them should not work alongside with them, but go immediately behind them, and closely inspect all they have done as the work proceeds, observing that they do not pass over any young trees requiring to be cleared, as well as seeing that those cleared be done in a proper manner. This operation ought to be performed twice during the summer season—viz., between the middle and the end of the month of June, and a second time in the month of August; and where the trees are growing among vegetation of a rank description, the same process may require to be repeated for two or three years successively, or at least until the young trees have risen above the rank growth of the herbage in the summer season.

1677. Young trees, besides being apt to be injured by grass and other common weeds, are often still more seriously hurt by furze and broom growing among them. It very often happens that young trees are planted where furze and broom have been cut down and not grubbed out by the roots, in which case the furze in particular is sure to push out a stronger and more vigorous growth than ever the following year. Wherever this may have been the case, the planter ought to have particular attention paid to such parts, and see that the young growths of the furze, as they rise up, do not hurt the young trees. For clearing away these shoots, a strong sickle will be found to answer the purpose well; and in the doing of the work, they ought to be shorn clean by the surface of the ground wherever they are found among the young trees, whether they may be injuring them in the meantime or not; for though the furze may not hurt the young trees in many places in a young plantation for the first year of its growth, it will decidedly do so the second year, when it will be much more difficult to get the better of it. Therefore it is always necessary to cut such rubbish during the first year of its growth, when in a soft state; besides, if it is allowed to stand undisturbed upon the ground for a whole year, it gives shelter to rabbits, hares, and other vermin, which are always a most dangerous stock in young plantations.

1678. Where furze has been, even although it may have been grubbed up, it is, we are aware, a most difficult matter to take it out so clean as to prevent any roots that may be left in the ground sending up shoots of considerable strength the first summer after; consequently, it is necessary to attend in a particular manner to those young plantations where furze has existed previous to the young trees being planted. We have frequently seen large tracts of young plantations entirely ruined from not having been cleared from rubbish in due time; and in such a case, where this necessary clearing of the young trees has been neglected, a replanting of the ground must take place before anything good can be expected. This of course is the cause of a great outlay of money, all which might have been saved had due attention been paid at first.

1679. The necessary expense of doing this sort of work is but trifling. We generally employ a man, with a number of young people proportionate to the extent to be operated on, from the beginning of June to the end of August, constantly clearing among the young plantations; and we find that where no furze is, the expense of keeping clear a young plantation for the first three years, taking the extent cleared, is about 16s. per acre; and where there is furze to contend with, the operation costs about 25s. per acre, until the trees rise above it.

In asserting the above, as to the expense of keeping young trees in a plantation clear of weeds, &c., we do not mean to say that the whole of the trees growing in a plantation will require to be so dealt with—that will depend entirely upon the nature of the original grasses, &c., growing on the surface. It is quite possible that not even one-fourth the extent of a plantation may require to have the young trees thus cleared; but wherever they are likely to suffer from weeds, &c., they should be attended to in the manner advised. Indeed, a good deal depends on the size of the trees used, as when these are large they require to be cleared only the first year, and in this case 5s. per acre will be found enough for the expense necessary to keep them clear of weeds—all depending on the size of the plants and the comparative strength of the herbage.

CHAPTER XII.

SECTION I.—UTILITY OF PROPRIETORS HAVING THEIR OWN HOME NURSERIES.

1680. That every proprietor of land who has occasion to plant young forest-trees to any considerable extent, should have a piece of ground adapted for the raising of young trees, is quite consistent with good management in forest operations. But, except in the case of extensive hill and moorland properties, on which a large extent of planting is annually and regularly carried on, which are situated far from public nurseries, and on which, therefore, it is often advisable, as a point of economy, to establish such extensive nurseries as to supply the greater part of the young trees required, we do not here mean to advise that every proprietor should be his own nurseryman; for the raising of forest-trees to such an extent on most estates where planting is only done by times, and not regularly, would be altogether out of the question. No proprietor's forester, however well qualified he might be, can possibly have sufficient time and opportunity to attend to the minute operations of raising young trees from the seed, from cuttings, layers, &c.; but we do assert that a piece of ground kept as a reserve nursery is absolutely necessary on such places, in order to good management.

In order to point out the utility of proprietors having their own home nurseries, and to show to what extent it is advisable for them to cultivate their own young trees previous to planting them out into the forest, we shall here give a statement as to our manner of proceeding on places of moderate extent with regard to this operation, and afterwards we shall also give an outline of our manner of proceeding with a nursery suitable for an estate where extensive plantations are being annually laid down.

1681. On estates where planting is conducted to a moderate extent, from 1 to 2 acres may be occupied as nursery-ground. In this all the oaks required may be raised from the acorn; and the forester should get a regular supply of acorns to enable him to keep up a succession of plants for planting out into the forest-ground every year.

Having such a piece of ground occupied as a nursery, the forester will be enabled to raise his oaks to a pretty large size previous to planting them out, which is of great advantage on many properties where there is much game to contend with; and, besides, when they are grown of a tall character they are not apt to be choked by long grass and strong weeds overtopping them. To get such plants as we here refer to from the common nurseries would cost a very high price, if they could be got at all—that is, strong well-rooted plants from 4 to 5 feet high; whereas, when reared in the home nursery, they cost the proprietor comparatively little. The forester need not raise all his oaks to a large size previous to planting them, but only a part, so far as may be required; and in order to have plants of a stronger and bushier character than he could have from public nurseries, he will have it in his power to give them abundance of room, plant from plant, in the rows. In the same way the forester may raise other hardwood trees to a large size, as well as pines, larches, piceas, firs, &c., as his case may require, which, when he has them grown to the desired strength, he can plant out into the forest-ground to fill up vacancies which may have occurred in the young plantations, or to make new plantations to have an immediate effect, if that is considered desirable.

1682. No proprietor's establishment of moderate extent can be said to be complete, as relates to his plantations, without such accommodation as we have just described. Without such a reserve nursery, no forester can have young trees at command in order to meet the demands of his employer, as occasion may sometimes require. Without such a reserve nursery, no gentleman can reasonably expect to have forest operations conducted properly. It would be folly to send 40 or 50 miles to a nurseryman for a few good trees to answer some particular purpose, when the same could be got more conveniently and more safely from the home nursery; and even after sending for them, they might not be such as were expected. Difficulties of this kind we have ourselves experienced in certain situations; but where we have had the accommodation of a home nursery, we have been able at all times fully to meet the demands of our employer, and that at a very moderate expense. Therefore it is that, having experienced the disappointments attendant upon the want of a reserve nursery, we would here urge every proprietor of moderate extent to adopt the system of having one, merely with the view of raising a few particularly good trees for particular purposes. The extent of ground to be occupied must of course be regulated according to the probable demand—that is, if the forest-grounds be somewhat extensive, two or perhaps three acres may not be too much; and if they are not, half an acre may be quite enough. In making such a nursery, never let it be in a sheltered or low-lying part, for there the young trees would be drawn up and weakly; neither make it upon a stiff clay soil, for in such a soil young trees never make good roots: but let the situation be rather an exposed one, with a light friable soil. There the young trees will become bushy and hardy, and also throw out numerous fibrous roots, which is always favourable to the healthy growth of young forest-trees having to be transplanted.

1683. The foregoing statements in regard to nurseries have reference only to such establishments as are suitable for comparatively small and moderately-sized properties. On extensive properties, say such as those on which there are from 6000 to 15,000 acres under wood, and on which there are some 300 or 500 acres of land planted annually, the case is altogether different. On Lord Seafield's Strathspey estate, for example, there are planted upwards of 1,000,000 of trees yearly. There there is a home nursery of some 12 acres in extent, in which are reared the greater part of the young trees required. In this nursery is kept a regular staff of people for the purpose, who attend to rearing the young trees of the various sorts to all the stages wanted, and by this means every tree used is naturalised to the climate before it is planted out, which is a great matter in tree-culture; and besides, from this establishment the proprietor is enabled to have his trees raised at a comparatively cheap rate. This, of course, arises from the extent being sufficient to support an establishment of people for the purpose, which could not follow the operation on a small scale.

SECTION II.—MANAGEMENT OF THE NURSERY.

1684. In the preceding section we recommended the establishment of reserve nurseries, in connection with the woodlands, on moderately small, and on somewhat extensive landed properties, say on those ranging from 4000 to 15,000 acres in extent, on which the woodlands might extend from 400 acres to 1500 respectively, as on such sized properties planting is not generally performed regularly, but only from time to time, on a small scale, and therefore would not pay the expense of keeping up a regular nursery establishment. But on the other hand, we recommended that on extensive hill and moorland properties, say on such as might range in extent from 30,000 to 50,000 acres, and on which it was contemplated to plant annually 400 acres for a series of years, regular nurseries should be established, both in order to facilitate the planting operations generally, and to have the supply of plants at the cheapest possible rate. As, therefore, we have found from experience that a regular nursery establishment is highly advantageous on extensive properties, where it is contemplated to plant on a large scale for a series of years, we propose in this section to lay down such a scheme of nursery culture as may be found suitable and advantageous for planting operations on large properties, say on such as those on which it is purposed to plant 400 acres annually for a period of fifteen or twenty years.

1685. As the establishment of such a nursery is necessarily attended with considerable expense at the outset, the whole thing should be carefully and maturely considered by the forester who is to manage it before he embark in it. If this is not attended to, disappointment to a very large extent may ensue. In taking up the subject, therefore, we shall do so at considerable length, in order to lay down such a groundwork of the art of nursery culture as may guide any intelligent forester who may undertake the rearing of young trees, for planting out and making large plantations on an extensive property.

1686. The first point to consider is the part of the property on which the nursery should be situated; and this, of course, should be as near to the centre of the intended planting operations as possible. If, however, after fixing upon a certain field for the site, it should be found that the land is of a heavy clayey nature, such a site should at once be objected to, as on it young trees, and especially those of the coniferous kinds, could not be expected to make such fibrous roots as are necessary in order to insure entire success in the rearing of the plantations to be made from it. In choosing the site, therefore, let it be on a light loamy soil, although it should lie a mile or more from the centre of the intended operations, as the advantages to be gained in the superior state of the plants from such a soil will far overbalance any disadvantages in regard to distance in carrying the young trees to their permanent positions.

1687. The point as to soil being arranged, the next is to see whether the site is satisfactory in other respects—namely, whether it be not too much exposed to cutting winds in spring, too much surrounded by wet and undrained lands, too much sheltered by trees, or having an eastern or northern aspect. In short, all these points should be avoided, as, if the site be too much exposed to cutting winds in spring, the young plants would suffer such a check as to impair their health and vigour; if much surrounded by wet and undrained lands, frosts would be induced in the early part of summer, and consequently the young shoots of plants of early growth would be injured; if much sheltered by trees, the young plants would become drawn up and of a weakly habit, and when put out into the plantation-ground, would suffer such a check as to prevent their progress for a considerable time; and if lying to the east, the effects of the morning sun in April on the plants after a night's frost would be injurious; and if to the north, the ground would be cold, and could not be satisfactorily wrought for the sowing of the seeds till the season was well advanced. In choosing the site, therefore, let the soil be rather light than otherwise; let it be neither much exposed nor much sheltered; let it be in a rather dry and cultivated part of the estate; and let it have a south or south-west exposure if possible, or at any rate nearer to the south and west points than to the north and east.

1688. These points all arranged, the next step is to ascertain what extent of ground will be necessary for the rearing of the quantity of young trees that may be required. We shall suppose that the estate on which the nursery is to be established is in a part of the country suitable for rearing oak and other hardwooded trees on the lower parts of it, and that it is found desirable and necessary to rear a large proportion of pine and larch, both for nurses to the hardwood, and for making pine and larch plantations, without hardwoods, on the higher parts.

1689. In paragraph 1684 we proposed to lay down such a scheme of nursery culture as might be found suitable for planting operations, to the extent of 400 acres annually; and in paragraph 1688 we assumed that the sorts required would be hardwoods of all the various kinds, with a large proportion of pine and larch, both for nurses, and for making plantations, exclusive of hardwoods, on the hilly parts of the estate. The next point, then, in order to ascertain the extent of ground required for the nursery, is the proportion of larch and pine plants that are likely to be wanted, as compared with the hardwooded sorts. We shall at once define this by supposing that 200 acres are to be planted annually on the lower parts of the property with hardwoods, and with larch as nurses; and that other 200 acres are to be planted annually on the higher portions, with an intermixture of larch and pine.

1690. From this it would follow that to plant 200 acres annually with hardwoods, at say 12 feet apart, about 61,000 of them would require to be produced annually, besides 484,000 larch as nurses; and that to plant annually 200 acres of the higher grounds with larch and pine, say in equal proportions, and at 4 feet apart, nearly 300,000 of each of these sorts would have to be produced to meet the annual demand; or, in all, as follows:—

Hardwoods,	61,000
Larch,	784,000
Pine,	300,000
	1,145,000

1691. These 61,000 oaks, including a few other hardwooded sorts, which are supposed to be required yearly, will occupy a space of nursery ground equal to about three-quarters of an acre; the 784,000 larch plants will occupy another space equal to 5 acres; while the 300,000 pines also required each year will occupy another space equal to 1½ acre—thus giving an extent of nursery ground equal to 7 acres 1 rood as having to be cleared of its crop each year successively, in order to plant 400 acres of the woodlands annually. Next, as the oak plants, which form the great bulk of the hardwoods, must stand three years in the nursery-lines before they are sufficiently strong to plant out into their permanent sites, these will require to be progressing at the different stages between one and three years—three regular successive crops of this tree, each on an extent of ground equal to three-quarters of an acre; and thus, under hardwoods alone, 2 acres 1 rood of the nursery-ground will be constantly occupied. Again, the larch plants must stand two years in the nursery-lines before they are fit for planting out; and as we have stated above that 5 acres of the nursery will be required to produce the annual quantity of that tree needed, there will, of course, be twice that number of acres necessary to keep good a regular succession of crop—that is, there will require to be 10 acres of the nursery-ground at all times under larch alone. The pine plants must also stand two years in the nursery-lines before they are fit—except in some cases, on which it is not, for our purpose, necessary to calculate—for planting out. We have said that 1½ acre of the nursery will be required to furnish the annual quantity of that tree needed, so that, as the plants must have two years in the lines, there must be twice that extent necessary to keep up the regular supply—that is, there will require to be 3 acres of the nursery-ground at all times under pine-trees alone. From these calculations, then, it is brought out that the whole extent of nursery-ground constantly under hardwoods, larch, and pine, must be 15 acres 1 rood. Besides this extent of nursery-ground, which must be kept constantly under a crop of young trees of the various successive ages required, there would also have to be a portion equal to three-quarters of an acre regularly put under green crop each year preparative for planting oak upon it the year following; and another portion, equal to 5 acres, would also have to be undergoing a similar preparation each year for the planting of larch upon it, while a third portion of 1½ acre would require to be similarly dealt with as a preparation for the planting of pine upon it the year following. In addition to these specified quantities, 1 acre would have to be allowed for the sowing of oak, larch, and pine seeds ; nearly half an acre for manure and compost heaps; nearly 1 acre as borders, for layering and engrafting various species of trees ; and 1 acre would have to be allowed for roads, walks, &c. The whole extent, therefore, of nursery-ground required for the rearing of trees sufficient to plant annually 400 acres of plantation land will stand thus :—

	A.	R.	P.
To be constantly under 1, 2, and 3 years' transplanted oak, with other hardwoods, ...	2	1	0
To be kept constantly under 1 and 2 years' transplanted larch,	10	0	0
To be kept constantly under 1 and 2 years' transplanted pine,	3	0	0
To be kept constantly under green crop, preparative for hardwoods, larch, and pine, ...	7	1	0
Allowance for sowing seeds as described, . . .	1	0	0
„ for manure and compost heaps, . . .	0	1	20
„ borders for layering out, engrafting, &c. &c., .	0	3	20
„ for roads and walks, &c., ...	1	0	0
Total extent of nursery required, . . .	25	3	0

1692. This seems a large extent of nursery-ground for the rearing of 1,145,000 plants annually, and it is indeed large in proportion to that on which public nurserymen would rear the same quantity of trees; but as in public nurseries the young plants are generally crowded and drawn up, and often no proper attention is paid to the rotation described, we are desirous to show to common foresters how a nursery should be managed in order to rear a sound and healthy stock, and not how it may be carried on so as to have their trees at the cheapest possible rate at the time of planting, as there is no doubt that the more healthily young plants can be reared the cheaper is the operation of planting in the end, and the more satisfactory its results in every respect. It is perhaps not generally known that when plants are crowded in the nursery-lines so as to take up the least possible space of ground, and produce the largest possible number of them from a given extent, they are badly rooted, and many of them die when put out. Besides this evil in regard to nursery culture, we have invariably observed that in nurseries where no attention is paid to green-cropping the land regularly previous to putting young trees upon it, they are unhealthy and stunted, and are therefore subject to disease after they are planted out; hence one great cause of the unhealthiness we observe in many young plantations at the present day. We maintain, therefore, that the extent set down is not too large for the object in view—namely, for the rearing of a healthy supply of trees for annual plantations to the extent and of the kinds described.

1693. We may however state, that if it were intended to rear larch and pine of the description called one-year transplanted, a few acres less than has been given would be sufficient, as, in such a case, the class of plants named would only remain one year in the nursery-lines, and consequently only one compartment of ground would be annually required for them, instead of two as in the scheme we have given. But we need not comment on this point, as every intelligent forester must be aware that, according to the number of years young trees are respectively required to stand in the nursery-lines, there must be a correspondent number of compartments in the nursery occupied by them, in order to keep up a regular succession for going out every year.

1694. The extent of ground having been fixed on—based on such calculations as we have given, and, in the case under consideration, it is supposed to be 26 acres in round numbers—the next step in the order of the work is to have it thoroughly drained. This should be attended to in an especial manner, as if not, the after-prosperity of the crop will be very unsatisfactory. One point to attend to in the drainage of land for a nursery is to have all the drains made so as to empty into a deep *well* on the lowest part of the site. This is, of course, meant to supply the nursery with water, to be lifted by means of a pump; and this done, a large drain should be made from the well, so as to allow the overflow water to escape from it at a point about 5 feet under the surface, and 1 foot under the level of the drains.

1695. The land having been drained, the next step is to have it trenched at least 2 feet deep. In doing this, all stones should be removed down to the size of a common hen egg, as the fewer stones there are left in the preparation of nursery-ground the better will the work of the culture be performed in it afterwards. In performing the work of trenching, the land should be levelled as far as may be judicious, considering its general surface, as it does not suit to level after trenching, because, were this done, some parts would necessarily have to be reduced, and would therefore be made poor compared with the parts that had soil added to them.

1696. The draining and trenching performed, say by the month of November, the land should be ploughed regularly all over, and left in this state to be ameliorated by the action of the frosts and rains of winter. The following season it should be properly ploughed and harrowed, so as to reduce the surface to as fine a mould as possible, and at the same time all stones that may have been left should be carefully removed; afterwards it should be drilled up by the plough, manured with good and well-rotted dung, and sown down with turnip, mangold-wurzel, or any such crop, in order to clean and enrich the soil, and bring it to a proper condition for after-use as a nursery for young trees.

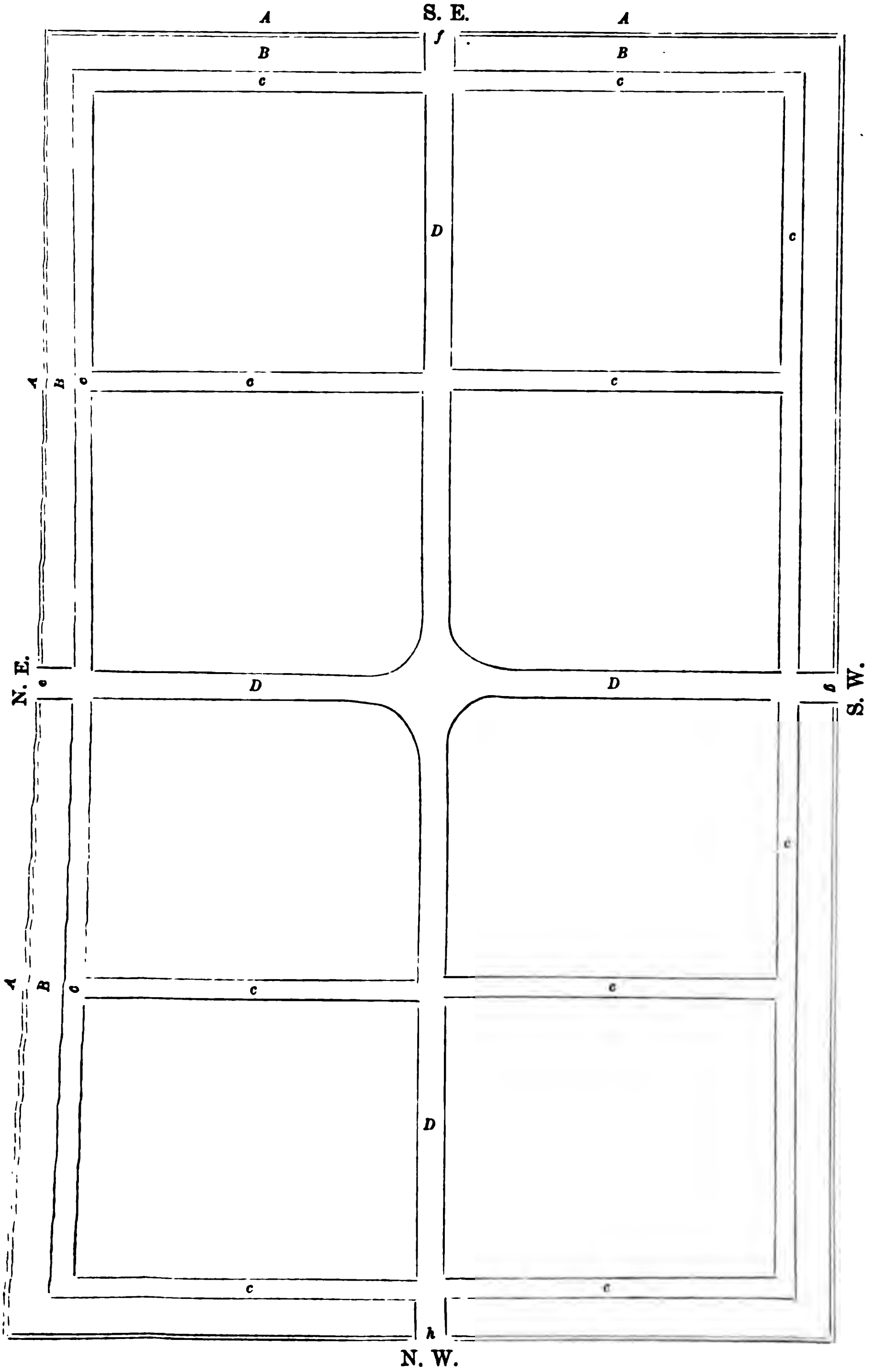
1697. During the summer, while this green crop is being cultivated on the proposed nursery site, it should be enclosed by a proper and substantial fence, if it have not one on it previously. This may consist of a stone wall, a hedge, a wooden paling, or a wire fence, as the circumstances of the case may suggest; observing in whatever kind of fence is erected to make it proof against hares and rabbits, as well as against heavy animals that may be grazed in the surrounding fields.

1698. We shall now suppose that the nursery-ground has been dealt with as has been described, in reference to draining, trenching, green-cropping, and fencing, and that the green crop has been removed from the land by the month of November. At this stage it is proper to take an account of the whole work, in order to learn what it has cost to bring it up to this point; it will probably stand thus:—

Drainage of 26 acres of land, say at £6 per acre, . .	£156	0	0
Trenching 26 acres, 2 feet deep, and removing stones, say at £10 per acre, ...	260	0	0
Sinking well and putting in pump, say . . .	10	0	0
Building large drain to lead overflow of water from well, say	8	0	0
Ploughing 26 acres of land after trenching, say . .	13	0	0
Preparing 26 acres for green crop, say . . .	30	0	0
Gathering stones, say	8	0	0
Manure, 520 loads, at 4s. per load, ...	104	0	0
Seed for and sowing green crop, say	12	0	0
Thinning and cleaning green crop, say . . .	15	0	0
Erecting stone wall as a fence, with wire netting on top, say 1452 yards, at 3s. 6d. per yard, ...	254	2	0
Interest on £447, as outlying for one year, say at 5 per cent,	22	7	0
	£892	9	0
Deduct from this value of green crop, say 26 acres turnips, at £6 per acre, ...	156	0	0
By this statement the nursery will be due the proprietor at the end of the first year of cropping, ...	£736	9	0

1699. For the sake of clearness in illustrating the subject, we shall now suppose that we have arrived at this stage of the nursery preparations in November 1880. Then, at that time, and after the green crop has been removed from the ground, it should be again ploughed regularly over, and left in the rough state, in order to have the full benefit of the winter's frost, &c., before commencing to plant it with young trees in the following spring. The land having been thus treated, the next step in the order of the work will be to have the roads and walks all made during the winter months, or at all events before the beginning of March, when planting and sowing operations will have to be commenced.

1700. We have not, up to this stage of our remarks on the nursery, said anything as to the form in which it ought to be laid out. With respect to this point we should say that the nearer it is made to the form of a square, it is the more likely to give satisfaction in regard to the respective operations of *lining*, *bedding*, and otherwise working in it afterwards. It may, however, be made in the form of a parallelogram, but on no account should the sides be made of unequal lengths, or curved, as in such cases we have found a great deal of trouble in getting the men to keep their lines—whether in the case of planting the young trees, or in that of lining off the beds for sowing the seeds—parallel with the walks and roads. When this point is not attended to, the grounds invariably look awkward and unsightly. Besides this, as a matter of economy, it is advantageous to have all the roads and walks laid off parallel and at right angles to one another; as when they are, the workmen's time is not necessarily taken up with calculations and measurements in order to arrive at certain points where other straight and parallel lines are required to agree with those in which they are engaged. By attention to this, much time and expense can be saved in the working of the whole. The following diagram will show how we should lay off the proposed nursery, with its roads and walks:—


S. E.
A
A
f
B
B
c
c
D
c
A
B
c
c
c
N. E.
e
D
D
g
S. W.
c
A
B
c
c
c
D
c
c
h
N. W.

1701. Having given this diagram, we propose next to make a few remarks in description of what it is meant to represent. The double outer line *A* represents the wall or outer fence enclosing the nursery in the form of a parallelogram, with its longest sides, each supposed to be 440 yards long, lying from S.E. to N.W., and its shortest, each supposed to be 286 yards, lying from N.E. to S.W., making in all an enclosure of 26 acres. The space running along the inside of the double line, and marked *B*, represents a border of 15 feet width all round between the wall and the walk *c*; and the two cross-walks which divide each of the four great compartments into two are marked *c* also, and are all 5 feet in breadth. The roads marked *D*, and which intersect the enclosure in its whole length and breadth, are supposed to be 12 feet wide; and in the middle of each of the sides is a gateway, as shown at *e*, *f*, *g*, and *h*. The object of this arrangement is to subdivide the whole ground into convenient portions, square on all their sides, and parallel to one another, so as to facilitate all the operations as much as possible, and to keep one kind of tree quite distinct from another. In the centre of the enclosure, and where the roads intersect, there is a large space left for the purpose of turning carts, &c., when it may be found necessary to do so.

1702. We have next to describe the manner of performing the work of subdividing the ground by roads and walks, as shown on the diagram. First, then, the whole land embraced should be made as level as the general surface will judiciously admit of; and this, of course, should be done in the act of trenching. This attended to, the roads from *f* to *h*, and *g* to *e*, as well as the adjoining walks marked *c*, should be made, by removing the soil from them to the respective breadths specified, and to such a depth as to obtain a pretty hard bottom for laying on road material; and in the removal of the soil from the roadways and walks, it should be spread equally over the borders and compartments, so as to improve them. The soil being excavated, say to the depth of 12 inches, a quantity of broken stones or rough gravel should be carted and laid in them, to the thickness of at least 8 inches, regularly over all. The making of the roads and walks brought to this stage, the next step is to have an edging of some sort planted along their sides, both in order to prevent the earth from the borders and compartments falling into them, and to present a decided, distinct, and neat appearance over all the grounds. We think that the best plant for this purpose is the evergreen privet, as it is not easily injured or thrown into bad health by being frequently trodden upon, as box and many other plants generally used for edgings are, when they are subject to rough usage. We have found the privet answer well as a road-edging in nurseries, and therefore recommend it to others for a like purpose. The plants for this purpose may be of the age called *one-year cuttings*, which are generally about 12 inches high. We need not here enter into a description of the work of laying in the plants on the lines which are to form the edgings on the sides of the roads and walks, as every forester is understood to be acquainted with such work; suffice it to say that the plants are simply put in as a low hedge along the sides of the roads and walks, all in such a regular way as to mark out distinctly the compartments on their sides.

1703. We shall now suppose that the edgings have been planted along the sides of all the roads and walks as described; the next thing to do will be to have them gravelled, which could not be well done till this stage, as, had they been gravelled before the edgings were planted, they would have been injured by the operation of taking out the openings for them on each side. In finishing the walks, good hard gravel should be used, and on no account soft or earthy matter, as, were such applied, they would become soft and unserviceable in autumn and spring, and would be difficult to keep clear of weeds in summer. In applying the upper coat of gravel, it should be put on 4 inches deep on the sides, and about 6 inches deep in the middle, so as to secure a slight fall from the middle to each side, and thereby throw off water as it falls.

1704. At this stage the nursery-ground will be in a state fit for the reception of both the seeds and the young trees which it is intended to rear in it; and supposing that the roads and walks shall have been all completed, say by the 1st of February, the forester should then arrange—if he has not done so previously—as to the procuring of the seeds and young plants of the various sorts he intends rearing; as, during the first year of a nursery, in order to hasten the usefulness of the establishment, it will be necessary to buy in young trees of the various sorts intended to be planted out into the plantations the following year, so as to have a stock on hand for use until plants shall have been reared from seeds sown in the nursery. In order to make this part of the subject clear, we shall give a statement showing the quantities of young plants and seeds that are likely to be required in commencing such an establishment as we have under notice. The statement is as follows:—

1705. Young trees required to be purchased the first year:—

Oak, 1-year seedlings, ...	45,000	£16	17	6
„ 2-year „	45,000	23	12	6
„ 1-year transplanted, ...	45,000	33	15	0
Ash, 2-year seedlings, ...	4,000	1	8	0
„ 1-year transplanted, ...	4,000	4	0	0
Carry forward, . .		£79	13	0

Brought forward, . .		£79	13	0
Elm, 2-year seedlings, ...	4,000	1	10	0
„ 1-year transplanted, ...	4,000	4	0	0
Beech, 2-year seedlings, ...	1,000	0	7	6
„ 1-year transplanted, . . .	1,000	0	12	6
Alder, 2-year seedlings, ...	500	0	3	9
Birch, 2-year „	500	0	5	0
Horse-chestnut, 2-year seedlings, . . .	200	0	4	0
Sweet chestnut, 2-year „ . . .	1,000	0	15	0
Lime-tree, transplanted, 4 feet high, . .	200	2	0	0
Maple, Norway, transplanted, 18 inches high, .	1,300	1	10	0
Sycamore, 1-year seedlings, . . .	1,300	0	7	0
„ 1-year transplanted, . . .	1,300	1	0	0
Walnut, 1-year seedlings, ...	200	0	8	0
Poplar, of sorts, 1-year cuttings, . . .	1,100	1	0	0
Willow, of sorts, 1-year cuttings, . . .	1,100	1	0	0
„ basket, of sorts, 1-year cuttings, . .	200	0	4	0
Scots Pine, 1-year seedlings, . . .	300,000	52	10	0
„ 1-year bedded, . . .	300,000	90	0	0
Larch, 1-year seedlings, ...	784,000	93	16	8
„ 2-year „	784,000	294	0	0
Spruce Fir, 2-year seedlings, . . .	2,000	0	6	0
„ 1-year transplanted, . . .	2,000	1	0	0
Silver Fir, 1-year „ . . .	2,000	1	4	0
Hedge plants—				
Hollies, 2-year seedlings, . . .	2,000	1	10	0
Thorns, 2-year „ . . .	12,000	4	10	0
Total for Plants, . .		£633	16	5

1706. The sorts and quantities of seeds that will require to be sown in order to secure a corresponding supply of plants for the following year will be as under:—

Oak, . .	6 bush.	Horse-Chestnut,	$\frac{1}{10}$ bush.	Thorn, . .	1 bush.
Ash, . .	$\frac{1}{3}$ „	Sweet Chestnut,	$\frac{1}{2}$ „	Scots Pine, .	38 lb.
Elm, . .	$\frac{3}{4}$ „	Maple, Norway,	$\frac{1}{7}$ „	Larch, . .	314 „
Beech, . .	$\frac{1}{10}$ „	Sycamore, .	$\frac{1}{7}$ „	Spruce, Norway,	$\frac{1}{4}$ „
Alder, . .	$\frac{1}{10}$ lb.	Walnut, . .	$\frac{1}{30}$ „	Silver Fir, .	4 „
Birch, . .	$\frac{1}{30}$ bush.	Holly, . .	$\frac{1}{4}$ „		

As an appendix to this statement, we may add that the quantities of the seeds of the different sorts named in it are proportionate to, and, generally speaking, sufficient for the rearing of similar numbers of plants to those detailed under paragraph 1705, of course with the exception of the poplars and willows, which are raised from cuttings, and of the lime, which is raised from layers. If foreign larch seed is used, however, a very much smaller quantity will suffice for the rearing of the plants required; indeed in that case about one-third of the quantity stated might be found enough.

1707. In our statement under paragraph 1705, we have given the cost of each of the quantities as we find the prices to stand this year (1880) in the catalogues of public nurserymen, while we have not given the cost of the seeds in paragraph 1706. Our reason for this is, that the prices of the seeds of forest-trees vary so much each year, according to the plentifulness or scarcity of the crops, that it is impossible to give anything approaching to a reliable estimate on the subject; and we therefore think it better not to give the prices at all, than to state such prices as may afterwards tend more to mislead than to inform. Another reason for not giving the cost of the seeds is, that, with the exception of the sweet chestnut, which must be imported, all the other sorts may generally be gathered in good seasons from old trees in any well-wooded part of the country, by young people employed by the forester, and this at a merely nominal cost. This, at least, is our own mode of going to work in regard to getting a supply of forest-tree seeds, and we think that a similar course ought to be pursued by every forester.

1708. The modes of gathering the different sorts of seeds detailed in the foregoing statement, the time of the year at which they are ripe, and the way in which they are dealt with in sowing, have all been described in the EIGHTH CHAPTER of this work, so that it is unnecessary again to refer to these parts of the subject. We may, however, state, in a general way, that all seeds should be gathered *only* while they are dry, and upon no account when in a wet state; as if so, they could not fail to spoil, and in great part to become useless. This point, therefore, should be carefully attended to in the gathering of all seeds of trees. Another point to be attended to is, to see that the seed is taken from trees in a healthy and vigorous state, and never either from young trees or from very old and diseased ones as a large proportion of the seeds taken from young trees are found abortive, and those taken from very old and from diseased ones, are found to want that vitality which is necessary for the insuring of healthful plants. We have gathered extensively the seeds of trees in many parts of the country, and from our experience of this branch of forestry, we advise all who may attempt to rear their own trees to be very careful in the selection of the subjects from which the seed is collected: if they are not, they will not only fail to have a sufficient number of plants from the quantities of seeds they may collect, but will also be sure to have a class of plants inferior in every respect, and of such a natural constitution as to involve their becoming matured at a very early period of their existence.

1709. In illustration of the point just referred to, we may state that we have known larch seed that was gathered from old and diseased trees fail to produce 1000 plants from the pound weight, while, when it is got from healthy and matured trees, it ought to give 3000. Perhaps it is not generally known among foresters, that the best larch seed that is usually collected from trees grown in this country is unfit for growing to the extent of from one-third to nearly two-thirds of the number of seeds it contains; and, as a rule, it generally follows that the greater the number of healthy seeds there are in a given weight of the seed, the more healthy and robust are the plants from it.

1710. For the information of those who may wish to cultivate nursery stock to a smaller or larger extent than has been here chalked out—viz., the rearing of plants to supply the planting of 400 acres annually—we shall give a tabular statement, showing what number of plants of the various kinds usually grown in our forests may be expected, under ordinary circumstances of the health of the seeds, from a given quantity of each respectively, and embracing several other points of useful information for foresters in the management of nurseries:—

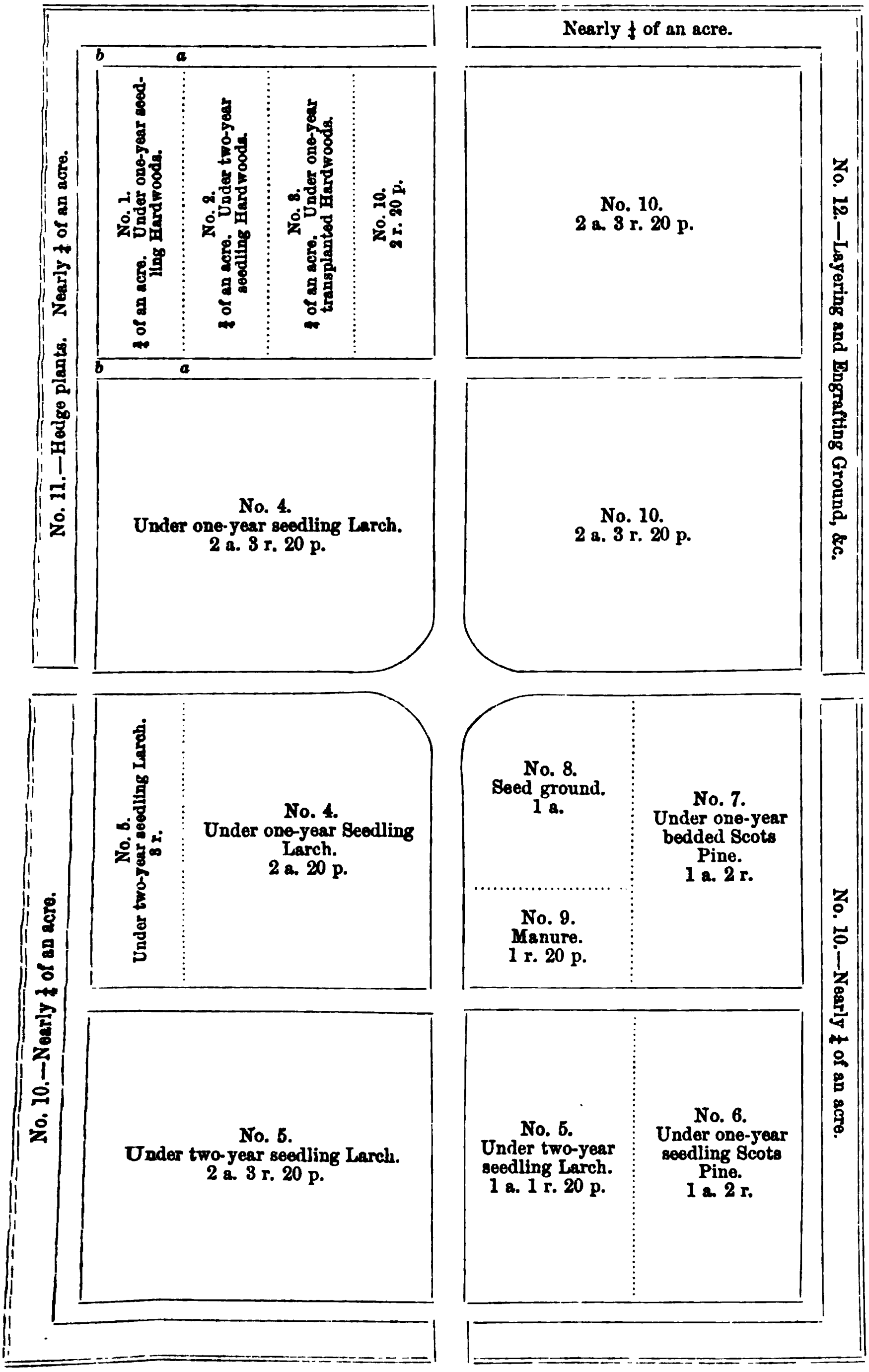
1711. TABULAR STATEMENT IN REFERENCE TO THE REARING OF NURSERY STOCK.

KINDS OF TREES.	Time of the year when Seeds are ripe.	Mode of preserving Seeds till sown.	Quantities of Seeds.	Will produce of Plants.	Manner of Sowing.	Depth at which Seeds should be sown.	Distance apart of Seeds when sown.	Age of Plants at removal from Seed-beds.	Age when fit to plant out into the Forest.
OAK . . .	November	Should be sown when gathered	1 bushel	From 6000 to 8000, according to quality	In rows 18 inches apart	2 inches	1 to every three square inches	1 year	4 years
ELM . . .	May and June	Will not preserve, but should be sown when gathered	1 bushel	From 5000 to 7000	In rows 15 inches apart	½ inch	1 to every two square inches	1 year	3 years
ASH . . .	End of October	In dry sand or light earth for 18 months, in order to rot the outer coat	1 bushel	From 12,000 to 16,000	In rows 15 inches apart	¾ inch	1 to every three square inches	1 year	3 years
BEECH . . .	End of October	In dry sand or light earth	1 bushel	From 10,000 to 12,000	In rows 15 inches apart	¾ inch	1 to every two square inches	2 years	4 years
ALDER . . .	End of October	In a dry airy loft	1 pound weight of the clean seed	5000	In beds	¼ inch	1 to the square inch	1 year	3 years
BIRCH . . .	October	In a dry airy loft	1 bushel of the clean seed	From 15,000 to 18,000	In beds	⅛ inch	200 to square foot	1 year	3 years
HORSE-CHESTNUT .	October	Should be sown when gathered	1 bushel	From 2000 to 3000	In rows 18 inches apart	2 inches	1 to every four square inches	1 year	3 years
SWEET CHESTNUT .	Seeds generally imported.	In a dry loft	1 bushel	3000	In rows 18 inches apart	2 inches	1 to every four square inches	1 year	3 years
NORWAY MAPLE .	Beginning of October	Should be sown when gathered	1 bushel	From 10,000 to 15,000	In rows 15 inches apart	¾ inch	1 to every three square inches	1 year	3 years
SYCAMORE . .	Middle of October	Should be sown when gathered	1 bushel	From 10,000 to 15,000	In rows 15 inches apart	¾ inch	1 to every four square inches	1 year	3 years
WALNUT. . .	Beginning of October	Should be sown when gathered	1 bushel	From 4000 to 6000	In rows 18 inches apart	2 inches	1 to every four square inches	1 year	3 to 4 years
HOLLY . . .	November	Should be rotted in a heap with sand for 16 months	1 bushel of clean seed	From 15,000 to 20,000	In beds	½ inch	1 to every square inch	2 years	5 years at least
THORN HAWS .	November	Should be rotted in a heap with sand for 16 months	1 bushel of clean seed	From 15,000 to 18,000	In beds	½ inch	1 to every square inch	2 years	4 years
SCOTS PINE . .	November and December	On shelves in a dry airy loft	1 pound weight	From 7000 to 10,000	In beds	¼ inch	2 to the square inch	1 year	3 years
LARCH . . .	November	On shelves in a dry airy loft	1 pound weight of home seed	From 2000 to 3000 only, a large proportion being generally bad	In beds	¼ inch	2 to the square inch	1 year	From 2 to 3 years
SPRUCE FIR, NORWAY . . .	November	On shelves in a dry airy loft	1 pound weight	From 8000 to 10,000	In beds	½ inch	2 to the square inch	2 years	From 4 to 5 years
SILVER FIR . .	November	On shelves in a dry airy loft	1 pound weight	About 500	In beds	½ inch nearly	2 to the square inch	2 years	5 years
PINASTER . .	Seeds generally imported	In a dry airy loft	1 pound weight	From 500 to 800	In beds	¾ inch	1 to the square inch	1 year	From 2 to 3 years

1712. With reference to the foregoing statement, we have to add that the numbers of plants which are stated as being produced from the respective quantities of seeds do not always hold good, as the result always depends upon the quality of the seed used, and upon the state of the ground in which it is sown; and we may add that the result is very much affected by whether the work of sowing and covering the seeds is properly or improperly performed. If the seeds are sown while the land is in a wet state, or if they are too deeply covered, the crops may be a failure, or at least partially so; but if the land is comparatively dry at the time of sowing, and the work in every respect properly performed, and if the different seeds used are of average qualities, the produce from them will be found, on the average, pretty nearly what has been stated.

1713. Having given the foregoing statements in reference to the quantities of plants and seeds required, &c., we shall next proceed to describe the modes of planting and sowing; and in order to do this the more clearly, we shall append another sketch or diagram of the proposed nursery. Before giving this, however, we must advert to what has been stated in paragraph 1704. It was there assumed that the nursery would be ready for the reception of the seeds and young plants by the 1st of February—which time will suit very well, in the generality of seasons, either for the sowing of such seeds as do not keep well over the winter, or for the planting of the hard-wooded sort of trees. The forester who intends such a nursery establishment as we are describing, will then have all the hard-wooded portion of the plants bought in as detailed under paragraph 1705, and have them *sheughed* and in readiness on the ground for planting out into lines. At the same time, it is also understood that the forester should have gathered in the previons autumn's seeds of the oak, beech, horse-chestnut, Norway maple, and Sycamore—all of which should be sown as early as possible after they are collected. All these in readiness for planting and sowing, the weather open and favourable, and the ground as dry as is to be expected at such a season of the year, the operations of the nursery should be commenced without delay; and to assist in describing them, and in order to show the quantities of ground to be occupied by the different crops, we now proceed to give the diagram referred to above:—

1714.


Nearly ¼ of an acre.
b
a
No. 1. ¾ of an acre. Under one-year seedling Hardwoods.
No. 2. ¾ of an acre. Under two-year seedling Hardwoods.
No. 3. ¾ of an acre. Under one-year transplanted Hardwoods.
No. 10. 2 r. 20 p.
No. 10. 2 a. 3 r. 20 p.
b
a
No. 11.—Hedge plants. Nearly ¾ of an acre.
No. 12.—Layering and Engrafting Ground, &c.
No. 4. Under one-year seedling Larch. 2 a. 3 r. 20 p.
No. 10. 2 a. 3 r. 20 p.
No. 5. Under two-year seedling Larch. 3 r.
No. 4. Under one-year Seedling Larch. 2 a. 20 p.
No. 8. Seed ground. 1 a.
No. 9. Manure. 1 r. 20 p.
No. 7. Under one-year bedded Scots Pine. 1 a. 2 r.
No. 10.—Nearly ¾ of an acre.
No. 10.—Nearly ¾ of an acre.
No. 5. Under two-year seedling Larch. 2 a. 3 r. 20 p.
No. 5. Under two-year seedling Larch. 1 a. 1 r. 20 p.
No. 6. Under one-year seedling Scots Pine. 1 a. 2 r.

1715. From this diagram it will be seen at a glance how we recommend to apportion the different crops over the ground. The compartments 1, 2, and 3, are each laid off, three-fourths of an acre in extent, for the three different ages of oak and other hard-wooded trees. The two compartments, Nos. 4, 4—the one containing 2 acres 3 roods 20 poles, and the other 2 acres 20 poles, and in all 5 acres, are laid off for the planting of the younger class of larch plants, called one-year seedlings. The three compartments, Nos. 5, 5, 5, one containing 2 acres 3 roods 20 poles, the other 1 acre 1 rood 20 poles, and the other 3 roods, and in all 5 acres, are laid off for the planting of the older class of larch plants, called two-year seedlings. The compartment No. 6, containing 1 acre 2 roods, is laid off for the planting of the younger class of Scots pine plants, or one-year seedlings, and the one, No. 7, containing also 1 acre 2 roods, for the older class of Scots pine, or two-year seedlings. The compartments Nos. 8 and 9, containing 1 acre, and 1 rood 20 poles, respectively, are laid off, as indicated on the diagram, for the sowing of the tree seeds, and for manure, &c. While the three compartments, Nos. 10, 10, 10, and the two borders, Nos. 10, 10, containing in all about 7 acres, are assigned for being put under some temporary crop the ensuing summer, and to be planted with young trees in the regular rotation the spring after; and the borders, Nos. 11 and 12, extending in all to half an acre, are laid off as under hedge plants and trees for the purpose of layering.

1716. We propose now, as we could not well have done till at this stage of our remarks, to describe the method of going to work in planting and sowing the different trees and seeds. But before taking up in detail this branch of the subject, it may be well to state that the forester should, if he possibly can, have engaged for the work some eight or ten expert men, who have been formerly somewhat accustomed to nursery operations, as altogether inexperienced men cannot be expected to do the different branches of the work so well or so satisfactorily as those who have been accustomed to them, and this he can always secure by having a few, say two or three at least, who have been some time in a public nursery, and who will on that account be able to teach the others how to operate along with them. It will also be necessary for the forester to have a good spade provided for each man employed, two large harrow-rakes, with wooden heads, say 24 inches long in the head, as used by nurserymen, two middling-sized iron ones, say 18 inches in the head, and two smaller ones, say 12 inches in the head, all to be used in bringing the earth to a fine state. He will also require to have provided, before the work commences, two good garden-lines, on properly made reels, as well as a 12-feet-long measuring-rod, distinctly marked in feet and inches all its length. With these preliminary instructions, we proceed to detail the work of the nursery in its order; and that this may be done systematically, we shall begin with compartment No. 1, and take up the others in their order.

1717. The compartment No. 1, as indicated by its description on the diagram, is the one proposed to be planted with the one-year seedling hardwoods, as stated under paragraph 1715. The only plants, therefore, which are specially intended for this compartment, are the 45,000 one-year seedling oak, together with the 1300 sycamore, and the 200 walnut, as it will be observed in glancing over the statement that, with the exception of those, there are no one-year seedling hardwoods specified. As, however, the extent of ground—three-fourths of an acre—is more than is necessary for the planting out of these hardwoods, it will be necessary to plant out in the same compartment the 4000 spruce and the 2000 silver firs, in order to fill up the whole of the compartment with plants of such a description as will be ready for removal at the same time with the oak, as these firs will be. Having made this arrangement as to the young trees that are to be planted in the compartment under notice, and having had them all properly sheughed at the one end of it, the workmen will next stretch their line from the one walk to the other, as shown on the diagram by the dotted line *a a*, in order to form a distinct boundary for the compartment. The line stretched as indicated, and to the desired breadth, to suit the extent of ground wanted, as from *b* to *a*, and laid down exactly at right angles with the two walks betwixt which it runs, the earth should be properly levelled, and made quite firm all along the run of the line, to the breadth of about 9 inches on that side on which the work is to be performed, and 3 inches on the opposite one. This attended to, the men engaged should be instructed to take out an opening, say 4 inches deep, along the whole length of the line, exact to its run, and upon that side of it on which compartment No. 2 lies. In doing this, the cut along the run of the line should be made to slope a little outwards, and the earth, as it is removed in making the opening, should be thrown upon the compartment No. 2, regularly as the work proceeds. This opening along the line finished, it will now form the boundary of compartment No. 1, and will afterwards form also the edge of a temporary walk which will be necessary betwixt compartments 1 and 2. The next thing to do is to have the line lifted, and again laid down, say 8 inches inwards, from the place on which it lay, and which was laid off as the boundary of the compartment. In lifting the line, care should be taken to lay it down again on the opposite edge of the levelled strip of ground, exactly parallel to where it lay, and 8 inches inwards on the compartment now to be operated on. This done, another opening should be made along its run, in every respect similar to the last, but of course this one must be sloped in the opposite direction, and towards No. 1. When these two openings have been made, a level and smooth strip, 8 inches in breadth, will present itself, running between the two walks from *a* to *a*, which will now form not only a distinct boundary to the compartment, but will also prove a guide to the workmen to keep the whole ground level as the work of planting proceeds, which is the chief object in view in the making of it.

1718. The men should next be directed to level, with their spades, the earth all along the back of the hedges forming the edging betwixt the walks and the other three sides of this compartment. This may be done to the extent of 28 inches in breadth, all round, and should be very easily done, as of course it is understood that the ground along the lines of the hedges was properly level when they were planted. This attended to, the line should be stretched along the backs of the hedges, say 24 inches inwards from them, and an opening taken out along its run, with the slope inwards. The compartment will now be surrounded by a level belt or strip, from which it will be an easy matter for the workmen to keep the land level in the operation of planting the young trees, and which could not have been well secured otherwise.

1719. The next branch of the work will be to have an opening taken out with the spade, along the end of the compartment opposite to that where the plants have been sheughed; and in doing this it should of course be taken out along the inside of the level edging just completed, but a few inches from it, in order that its smooth edge may not be disturbed by the spades. As this opening is made, the earth from it should be put into wheelbarrows and removed to the opposite end of the compartment, and there laid carefully down along its whole length, in such a way as not to interfere with the other smooth edging made along the back of the hedge, nor with the plants that were sheughed, but in a line betwixt the two. At this stage, the compartment will be in a state of readiness for planting the young trees in lines, which operation is performed in this manner.

1720. Supposing that the smooth edging has been completed along the end of the compartment, and which was specified to be made 24 inches inwards from the hedge, and that the opening has been taken out along the inside of it, say to the depth of some 5 or 6 inches, the workmen will prepare it for the first line or row of young trees, by making it as nearly as possible perpendicular, as, if its side were left in a sloping position, the plants could not be easily set upright against it. This prepared and in readiness, the young hardwood plants should next be brought forward, say the oak first; not in large quantities, but only as many at a time as will plant from three to four rows; and as they are thus brought from the sheugh to the ground in which they are to be planted, the foreman of the workmen should sort them evenly in his hand, and cut off the extreme points of the roots, in order to cause them to become more fibrous. He will then lay them down evenly and flat on the ground, and spread a little earth over their roots, in order to prevent the wind or drought from drying them; as the more carefully the plants are dealt with in this respect, the more likely are they to succeed well afterwards. The next point that the forester will have to attend to, will be to have the length of the row to be planted properly apportioned to the number of men he may have engaged in the work. To decide this point, we shall suppose that there are eight men employed, and that the length of the row is 48 yards; here, then, it follows that each man will have to plant 6 yards of each line as his portion, so that the forester should accordingly measure off the ground for them, and make each man, before he commences, put up two pins in the levelled border where he is to begin, at right angles with the line of the rows, and at the point his portion is to terminate, and about 2 feet apart. The object of this is, that when the men commence they have only to begin the first plant at the point where the eye comes in a line with the two pins set up on the one hand, and to terminate where the eyes comes in a line with the two pins on the other. By adopting this simple mode, each man will have justice in the work, and such an emulation will be sure to be excited among them as will cause it to go on briskly. These points all properly arranged, each man must next be directed to take in his hands as many plants as will be sufficient to plant his portion of the row, which is here supposed to be 6 yards. Then, as the plants are to be put in the rows at 4 inches apart, the men will each have to lift 54 plants for one row. Each having thus supplied himself with plants, the forester should instruct every one separately how to lay them down on the top of the smooth edge of the opening, regularly in small quantities, say in tens, and at regular distances apart, in order to be the more conveniently handled and got at while planting them. Next, the men having the plants all arranged and laid out, each will take his position on the left-hand side of the portion of the row he is to plant, and kneel down on his left knee, with his left side towards the newly-cut edging. In this position he will take a plant in his left hand, and between the forefinger and thumb, laying hold of it about one inch above the part forming the junction between the stem and the root proper; this part of the stem he will place exactly on the angle on which the line rested when the opening was made for the roots of the plants, and at the extreme left-hand side of his portion to be planted, keeping the second joint of his forefinger flat on the angle, and his thumb downwards. The first plant thus held in the left hand, he will, with the right one, draw together a quantity of the finest of the loose earth lying in the opening before him, sufficient to cover properly the roots and to keep it in its place, and this he will lay upon the roots in a careful and proper way, giving it a slight press with the right hand to prevent its getting detached from the smooth wall of earth, and thereby allow the plant to fall from its place. In the same manner, each man should be instructed to plant all the young trees that fall to his portion in the line, observing to put them in as exactly as possible 4 inches one from another. The plants of the first line being all put in their places in the way described, the men will next take their spades and add a little more of the finest of the earth to that already laid on the roots with the hand, but only to such an extent as to secure the roots being covered regularly with about 3 inches of it, when the whole length of the line of plants should have the loose earth gently firmed over the roots, by a very slight tramping with the forefoot. The work brought up to this stage, the men should next dig backwards by narrow spits, and lay the earth on and towards the roots of the plants till they are sufficiently covered, and till the turned-up soil is one foot in breadth, or so, betwixt the plants and the opening, when a fresh adjustment of the plants should take place along all the length of the line. This should be done by the men examining each his portion, and taking hold of such of the plants as seem to lie to one side, and setting them upright by a slight pressure with the forefoot. After each man is satisfied that his plants are rightly put in, he should commence to dig the earth full up to the general level, and continue this till he has fully 2 feet in breadth of the dug ground betwixt the row of trees and the opening under his feet, when another edging should be made to receive another line of the young trees.

1721. At this stage of the work, two pieces of wood will be required as *measuring-sticks* for laying-off the rows at regular distances, and parallel to one another. These, of course, should be provided before the work commences; and as in the case of planting under notice the rows will have to be 2 feet apart, the *sticks*, as they are called, should be made exactly 24 inches in length. One should be given to the man on the extreme left, and another to the man on the right of the row, as they will have to measure the distance and adjust the line as each new edging is made. The men on the extreme ends thus provided, they will lay their measuring-sticks down, the one exactly on a line with the edging, which was cut 24 inches back from the hedge on the one hand, and the other exactly on a line with that forming the boundary on the other; and in doing this, each man will place the one end of his stick at the terminal tree of the line just planted, and mark off 2 feet on the edging, and place the line—which they raise betwixt them—accordingly, for preparing a new edging for a new row. This is done by stretching the line tightly between the levelled edgings running along the sides of the compartment, and afterwards levelling and beating the earth on the run of the line as before. An opening is taken out along the run of the newly-laid line to the depth formerly specified, into which to plant the second row of trees, which is performed in every respect as has been described in regard to the first.

All the plants intended to be planted in compartment No. 1 should be dealt with in the same way till the whole are finished, taking care, as the work proceeds, to see that the lines or rows are kept at right angles with the sides of the compartment, and perfectly parallel one to another; as, if this be not attended to, and they are allowed to run diagonally, the work would look badly, and give the grounds an unpleasant appearance.

1722. The one-year seedling plants all put in as directed, the silver and spruce firs, which are of slow growth when young, may be planted along with them. In doing this, the same mode of operation is continued, and should be begun just where the planting of the hardwoods terminates. There is this exception to be observed, however, in the case of planting these firs. As they do not grow so rapidly as the hardwoods during the three years they are to stand in the nursery, they do not require so much space betwixt the rows as the hardwoods do; but as they form more dense heads, they require to have a little more distance betwixt the plants in the rows. The distance betwixt the rows of the firs may therefore be 18 inches, while that betwixt the plants may be 5 inches. Many nurserymen plant these sorts even closer than we have just specified; but in such cases the plants are always found much drawn up, and consequently weakly in constitution. With reference to the firs, we have still to remark, that although they are stated as of two ages—viz., two-year seedlings and one-year transplanted—still they should all have the same space allowed them betwixt and in the rows, as the object is to have two classes of plants three years afterwards, to suit different characters of ground, one a little taller than the other, but both equally robust and healthy. Another point to attend to in the planting of such firs in nursery rows, is to see that they are not too deeply set in the earth, as they never succeed well when this is the case. In planting them, therefore, the foreman should be particular to see that the men put them in only to the depth they have stood in the seed-bed, or in the former lines.

1723. Having finished the description of the manner of dealing with the class of plants specified in regard to compartment No. 1, we proceed to detail how the two-year seedling hardwoods should be dealt with in planting them on compartment No. 2. But in taking up this part of the subject, it is not necessary that we should enter into particulars regarding the operation of planting, since we have described this so minutely in reference to the class already referred to, and the same mode is applicable to both. On compartment No. 2, as indicated on the diagram, it is proposed to plant all the two-year seedling hardwoods, which, according to the statement given under paragraph 1705, will stand thus:—

Oak, two-year seedlings,	45,000
Ash, ,, ,,	4,000
Elm, ,, ,,	4,000
Beech, ,, ,,	1,000
Alder, ,, ,,	500
Birch, ,, ,,	500
Horse-chestnut, ,,	200
Spanish chestnut, ,,	1,000
In all,	56,200

There are thus 56,200 two-year seedlings to plant out on compartment No. 2, including the eight different sorts named. In preparing this compartment for planting, its boundaries should first be properly levelled and marked off, as described in reference to those of No. 1, leaving an alley or little walk of 2 feet breadth betwixt them. This done, the plants should be brought forward and sheughed at one end of it, and the opening taken out at the other preparative to planting, and they should all have the points of their roots removed, as advised for the one-year seedlings. The work of planting them in the rows should then be proceeded with in every respect as has been described in reference to the one-year seedlings—but with this difference, that the two-year seedling plants, from their roots being proportionately longer, will necessarily have to be put deeper into the earth.

1724. The oaks planted first, the ash, elm, beech, alder, and Spanish chestnut may all be made to follow them in their order, of course keeping each sort distinct from the other; and they as well as the oak should be planted 2 feet apart betwixt the rows, and 4 inches apart in them.

1725. As the horse-chestnut generally grows stronger than most other hard-wooded sorts while young, in planting them in rows in the nursery they should be kept about 6 inches apart, but they need not be planted more than 24 inches row from row.

1726. The birch being of comparatively slow growth, it is not necessary that the plants of it should have more than 18 inches betwixt the rows, and 3 inches plant from plant in them.

1727. In planting out into nursery lines the two-year seedlings enumerated above, as they are taller than the one-year plants, with but weakly fibres on their roots, greater care is necessary to have them made properly firm in the earth than in the case of smaller plants, so that very considerable attention must be given to see that this point is properly attended to: if it is not, many deaths are sure to take place. In short, in the case of the greater part of our useful forest-trees, we always object to using two-year seedlings at all, as they are always more difficult to rear than one-year seedlings; and this arises from their having fewer and more weakly fibres than the one-year class—that is, compared with the size of the plants. Our reason for recommending the introduction of two-year seedlings at all into the nursery scheme we are describing is, that at the outset of such an establishment it is found desirable to use them in order to have plants for use as early as possible. In a well-regulated nursery establishment of some years' standing, this class is not generally found necessary, as there the different successions are kept up regularly from one-year seedlings, with a very few exceptions.

1728. On compartment No. 3, it has been arranged that the class of hardwood plants called one-year transplanted should be used. According to the statement under paragraph 1705, they will stand thus:—

Oak, one-year transplanted, ...	45,000
Ash, " "	4,000
Elm, " "	4,000
Beech, " "	1,000
Maple, Norway, "	1,300
Sycamore, " "	1,300
Poplar, " "	1,100
Willow, " "	1,300
In all, . . .	59,000

In planting the different sorts above enumerated, the boundaries of the compartment are to be first marked off as already described in reference to the preparation of the others, and the kinds made to follow one another in masses respectively as stated—putting the oak first, and the poplars and willows last. The whole should be planted 2 feet between the rows, and 4 inches apart in them. Care should be taken to plant this class proportionately deeper than either of the two already referred to, as they are taller, and therefore require a deeper hold of the earth. The only rule that can safely be given in this respect, is to see that all the root part of each plant is properly covered, with a very small portion of the stem above—say not more than one inch. We make this remark here, as we have invariably found deep planting, whether in the nursery or in the open forest, very injurious to the health of the plants so dealt with. We do not consider it necessary to enter further into the planting of the class of plants under notice, as anything we could say more would be a mere repetition of what has already been stated.

1729. Having now described the manner of proceeding with the three different classes of hardwoods, we next come to the one-year seedling larch, which, according to the scheme laid down on the diagram, are to be planted in the two compartments numbered 4, 4, extending in all to 5 acres. The number of young larch to be planted in this extent, according to the statement in reference to them under paragraph 1705, is 784,000. This quantity, then, planted at about five plants to each foot in length in the lines or rows, and 16 inches row from row, will, as nearly as possible, occupy the whole of the two compartments allotted for them, after deducting allowance for alleys. As, however, it would not be found convenient to plant such large compartments as the two under notice from side to side all in one piece, for the sake of conveniently working among the young trees in them in the summer season, it will be an advantage to have the entire compartment, or the one adjoining that in which the hardwoods are supposed to be planted, divided into four equal portions, and the other one lying on the opposite side of the middle road, and adjoining the smaller one of No. 5, divided into three. This can be easily accomplished, and ought to be the first thing attended to in the work of preparation for planting, by running alleys through them from hedge to hedge on each side, and in lines exactly corresponding to the alleys dividing the compartments supposed to be planted with hardwoods. Such a mode of subdividing such large compartments is indeed absolutely necessary, not only to the satisfactory working of the men in the time of planting, but, as we have already hinted, also while cleaning the ground. In laying off these alleys, they should be made 24 inches broad, and levelled on the sides, and properly edged off, in every respect as recommended for the same description of work in reference to the divisions of the compartments Nos. 1, 2, and 3. And the ground behind the hedges surrounding the compartments should also be levelled and edged off in a neat way, for the guidance of the men in planting, as formerly described in reference to the hardwood compartments. The compartments will now be in readiness for receiving the plants.

1730. It is, of course, to be understood by the forester that, in purchasing his seedling larch plants for a nursery stock, he should have them of a first-rate class, *stout*, and on no account of a weakly habit, as the success of the after crop from them will entirely depend upon whether he choose plants of a weakly or strong constitution. If he unfortunately choose them of the former class, the trees produced from them will most assuredly be of a similar character; while, if he have the good sense and skill to choose them of the latter description, this characteristic is an indication that they have been reared from sound seed taken from sound trees, and that a crop of good sound trees may reasonably be expected under ordinarily fair circumstances of after-management. The criterion, in regard to really good one-year seedling larch, is plants not tall nor drawn up, but stout and firm of stem, and on the average not much over 3 inches high above the root, with the buds large, prominent, well ripened, and well defined. Many are in the habit of choosing their seedlings of the class under notice more for their height than for any other quality, which is a great mistake, as we have invariably found that larch seedlings are taller in proportion as they are crowded in the beds and rushed up by force of manure. Weakly plants may be drawn up tall so as to appear to have made great growth, while in reality they are soft in the texture of their wood, badly ripened, and small budded, and therefore of the most inferior description; while plants of a naturally strong constitution, under all circumstances, will be firm in the texture of their wood, and present large and prominent buds.

1731. The plants having then been purchased of the best character, and laid in by the roots at the ends of the several subdivisions of the compartments opposite those at which it is intended to commence planting, the work should be at once proceeded with as advised and described in reference to the planting of the one-year seedling hardwoods, but with this exception, that no pruning of the roots of the larch is necessary. We may here remark, however, that in planting the larch, what was stated in paragraph 1729 as to the distance apart of the plants, both in the rows and betwixt them, should be kept in view and applied.

1732. As each of the sub-compartments is finished, it should present a uniform level surface from side to side; and if the earth is in any way rough and difficult to reduce to a fine mould, the more time should be bestowed on the work, as unless, in the case of planting such small trees, the earth be reduced to a very fine state as it is laid to their roots, many will fail to grow, from its openness about them allowing the drought to get to them.

1733. The planting of the one-year seedling larch finished, the next class in the order is the two-year larch, which, according to the diagram, are proposed to be planted on the three portions numbered 5, 5, 5. As the subdividing of these by alleys for the convenience of planting and after-working, the levelling of the boundaries, and making the edgings along them, are in every respect the same as has been described for the compartment No. 4, we need not lengthen our remarks on these points. We have to state, however, that this class of plants should be planted 3 inches apart in the rows, and 18 inches between the rows. We have to add that the plants should be very carefully chosen, as when larch or pine have stood two years in beds they are generally so much drawn up as to be weakly both in their stems and roots. Great care should, therefore, be exercised by the forester to see that he get them from beds that have not been overcrowded; and in planting them, to have their roots first carefully mulched in a fine creamy mixture of earth and water, as if this should not be attended to, and dry weather set in shortly after planting, from the weakness of their roots it could not fail that a large proportion would die. Another point which should also be especially and carefully attended to in the planting of two-year seedlings is, that they should have their roots carefully embedded in the finest and richest portions of the soil, and that as each row is planted, the plants forming it should be well supported on the surface by the finer particles of the earth being applied to fill up all interstices on the surface above the roots, and pretty firmly beat in with the backs of the spades, so as to prevent drought from taking effect quickly.

1734. The next class of plants are the one-year seedling Scots pine, which it is proposed should be planted on compartment No. 6, extending to 1½ acre. The statement given under paragraph 1705 shows that it is proposed to plant 300,000 on this 1½ acre. This, then, will be accomplished after making deductions on the score of alleys for the subdividing of the compartment, by planting the young trees 14 inches betwixt the rows, and by placing them 2 inches apart from one another in the rows, which is fully a greater distance plant from plant than is allowed for the same class of plants by public nurserymen; but of course this is to the advantage of the plants ultimately, as thereby they have the advantage of more space to develop themselves perfectly, to attain which is our object. We need only state further, with regard to this class of plants, that in respect to the laying off of the subdivisions for conveniently planting them, and the mode of doing the work, the recommendations given in reference to the planting of the one-year larch are in every respect applicable here also.

1735. Compartment No. 7 is proposed to be planted with the 300,000 one-year bedded—one-year seedlings, one-year closely transplanted—Scots pine stated in paragraph 1705; and as these should be dealt with as to distance apart in every respect as stated in paragraph 1734 for the one-year seedlings, we need not recapitulate what has been said on the subject.

1736. We have now described the mode of planting the different sorts and ages of young trees out into rows in the nursery, as practised by the most intelligent and experienced nurserymen in the country; but our remarks being applicable to a home nursery, which should in all cases be conducted on the soundest principles, we do not take into account other modes of planting which are adopted in many public nurseries for the sake of saving time. Before taking up the subject of sowing the seeds of the different trees it is intended to rear—which branch, according to the order of the numbers on the diagram, falls next to be discussed—we think it desirable to give a few paragraphs in explanation of certain points bearing upon the work, and which the forester should properly understand and keep in view, in regard to the working of the nursery generally.

1737. We stated in a former part of this section that the work of planting should be begun not later than the 1st of February. This statement might lead many to suppose that the month named was considered the best time for commencing the work. We do not, however, mean to infer this, as we begin our nursery operations in the month of November, and continue them throughout the winter while the weather is open, and therefore favourable, even till the middle, and sometimes till the end of the month of May. Our reason for having recommended the month of February for beginning the work, in the case of the nursery under notice, is, that as the whole of the ground devoted to it had been under green crop, and only supposed to be newly cleared from it, and as the roads and walks had to be laid off on it, made, and completed, as well as the edgings along the sides of them, before the work of planting could be properly commenced in the compartments, sufficient time had to be allowed for the proper performance of these operations; and therefore we allowed the months of November, December, and January for them, with the restriction that the work of planting should be begun by the 1st of February at latest. With these explanatory remarks, we recommend, what we do ourselves, to commence the planting of the hardwoods into rows in the nursery immediately after they have sufficiently ripened their shoots, which is generally about the 1st of November. By attention to this point the hardwoods will, in all probability, be got put out at any rate by the end of December, when the work of planting out the pines and larch will be better and more leisurely attended to in the spring months. But upon no account should the operations of the nursery be performed in frosty weather; as if so, the very tender fibres of the young plants will be killed, and their after-progress affected in consequence.

1738. The forester who has the management of a nursery should be very careful to attend to the planting of small seedlings while the weather is decidedly open and favourable, and even somewhat wet, as their fibres are very tender, soft, and therefore easily injured by sharp drying winds. There is not, however, so much danger in this respect in the winter as in the spring months. It sometimes happens that when there is a large extent of woodland to plant in the autumn, all hands are called off for the purpose of having this performed; especially when the season happens to be generally unfavourable for planting, so that it has to be done by times as found suitable. In such cases the nursery work is unavoidably neglected for a time, in order to get forward that of planting in the enclosures; so that from this cause it will often happen, under the best management, that the nursery work is for the most part to be performed in the spring months, and after the planting in the plantations has been got well through for the season. According to the state of the weather, this often happens with ourselves in regard to our nursery work; and when it does, we make it a point—if the weather be at all windy and drying—to dip the roots of all the young plants into a creamy puddle immediately on their being lifted from the beds, and before they are put into the sheugh. This prevents the air from taking effect upon their roots, and keeps them safe till planted.

1739. No planting of one-year seedlings should be performed till the season is so far advanced that there is no risk of frost continuing for any considerable length of time, because, if a strong frost should set in immediately after one-year seedlings have been transplanted, they are likely to be very much injured, and even thrown out of the earth altogether. In order to avoid this state of things in regard to one-year seedlings, we make it a general rule in our nursery establishment to transplant all large hard-wooded and other kinds in the autumn and beginning of winter; two-year seedlings, if we should have occasion to use any, from the middle of February to the 1st of March; one-year seedling larch from the 1st of March to the 1st of April; and all one-year seedling pines and other conifers chiefly during April, and up to the middle of May if necessary.

1740. The next subject proposed to be referred to in connection with the nursery is the sowing of the tree-seeds, as specified under paragraph 1706, and which, according to the diagram, are proposed to be sown on compartment No. 8, extending to one acre. Having given the tabular statement under 1711, it seems almost unnecessary to make any other remarks in regard to this operation, as this statement itself shows at a glance all that is necessary to be said on the subject. In short, this statement gives a condensed view of the modes of rearing the several sorts specified in it, from the sowing of the seeds to the time the plants should be planted out. We consider, therefore, that with this statement, and the remarks made in the foregoing part of this section, together with those made in the eighth chapter of this work, on the nature of rearing each sort of tree respectively, any intelligent forester could be at no loss to undertake the sowing and rearing to planting-state of the different sorts of trees referred to. For the sake of the young men in the profession, however, who may not have had the advantage of practical experience in any public nursery, we shall give very short directions for the sowing of each of the sorts of seeds stated under paragraph 1706.

1741. The first in order is the oak. In providing the acorns, as we formerly hinted, great care is necessary to see that they are of such a quality as to insure a healthy and strong-constitutioned class of plants. If this point is not attended to, and the seed got of an inferior description, the plants will assuredly be worthless in consequence. We have invariably found that the larger the acorns the stronger and the more healthy are the plants produced from them, and therefore the better is the class of timber-trees also. The acorns should be collected only from trees that have arrived at considerable age, and are of large magnitude as timber, and healthy in all their parts. Seed gathered from comparatively young trees, although seemingly of fair size, seems to want that degree of vitality which is necessary to produce strong healthy plants; and seed gathered from very old trees, especially if in a state of decay, is small, and therefore unfit to produce sound-constitutioned plants. We shall suppose that the acorns have been collected of a proper description, say in dry weather, some time in the beginning of November, and of the quantity required—namely, 6 bushels. As they are gathered they should not be put into bags—unless, indeed, they are to be carried a considerable distance, in which case it will be necessary to bag them for the sake of convenience in carriage—but carried home in open baskets, and stored thinly on the floor of a loft till the desired quantity is secured. While they are being gathered, a piece of ground should be prepared for them on the part of the nursery on which it is intended they should be sown. This preparation is only to dig the ground very finely, and to use the large rake as the work of digging progresses, in order to bring it to a finer mould than could be done by the spade alone. All in readiness for the sowing, this should be done in parallel rows, 15 inches apart, centre from centre. Our own plan is to sow the acorns on the surface; and this we do on a good day, when the earth is pretty dry, and when the particles of it do not readily adhere to one another. We first stretch the line from side to side of the compartment, and where the first row is intended to be sown; next, we take a quantity of the seed into an apron, tied on for the purpose of holding it, and, beginning at the one end of the line, we go along, keeping one foot on each side of it, and place the acorns, as nearly as we can judge, one to every 3 square inches, and keeping the row of seeds on each side of the line, and from 5 to 6 inches broad, taking the run of the line as the middle of the row. The first row thus sown, we remove the line to the distance of 15 inches from its first position, keeping it parallel to the first row; and in the same way we continue to sow in lines till all the seed has been sown. We next cause a man to take his spade and lift, in a direct line along betwixt the first two rows, keeping his spade in a line with the surface of the earth, a quantity of the surface-soil sufficient to cover the seed to the depth of fully 2 inches; and this he lays on the first row, in spits of the desired thickness, till the whole seed of the first line is covered; then he does the same with the next line, and so on. By this mode of covering with the spade the seeds are covered in an equal and careful manner all over, which we have found cannot be so well done by the old mode of covering with the rake or the hoe; as when these tools are used many of the seeds are displaced, and they therefore come up irregularly. The seed thus sown and covered, a fine rake should be used to smooth the earth by which it is covered; and as the man proceeds with the operation, he should be instructed to take care not to disturb the seed by raking deeply, as is very apt to be done by inexperienced hands. By sowing on the surface, and by taking out the earth betwixt the rows for covering, the seed is kept on a dry bed all winter, as the water has always a tendency to be drawn towards the hollows betwixt the rows, and from this the plants come away early in summer, and have the advantage of ripening their wood early in the autumn. The very opposite of this is generally the case in regard to plants raised from seed sown in drills.

1742. The seeds of the ash having been gathered from healthy trees in the month of October, they should be mixed with sand for rotting their coats, and treated as recommended in Chapter Eighth of this work, where special reference is made to the ash. The mode of sowing the seed of this tree, after it has lain a sufficient time to have its coat rotted, is in every respect the same as that just recommended for the sowing of the oak, with this exception, that the ash is generally sown in rows from 12 to 15 inches apart, in the month of March, and that they are covered with only three-fourths of an inch of earth.

1743. The elm generally ripens its seed in June, and must be collected from the trees before it falls. It also is sown in lines from 12 to 15 inches apart, one seed to every 2 square inches, and covered only with half an inch of soil. In sowing the seed of this tree, it must be kept specially in view, however, that as the seeds are very soft and tender when newly gathered, and therefore easily injured, the soil in which they are sown, and with which they are covered, should be made as fine as possible, and the operation should be done on a dry day, when the earth has no tendency to bind or adhere to the seeds, as this would have a tendency to rot them.

1744. The seed of the beech ripens freely, in the generality of seasons, in the months of October and November, and is easily gathered as it falls from the trees, when it should be mixed with sand to be preserved till March, when it is to be sown. In doing this, it is to be sown in lines from 12 to 15 inches apart, one seed to every 2 square inches, 5 inches broad in the rows, and covered with about three-fourths of an inch of earth. This is a very hardy and free-growing seed, but the plants are always small at first, and therefore they require to stand two years before they are fit to be put out into nursery rows.

1745. The alder ripens its seeds in October and November (see directions in regard to collecting the seed of this tree in Chapter Eighth), and should be sown in the month of March following. The seeds are sown in beds generally 4 feet broad, and on pretty finely prepared earth, in the proportion of one seed to the square inch, and covered with about one-fourth of an inch of earth. The way we sow in a bed such a small quantity of seed as that we are referring to—viz., one-tenth of a pound—is this: We lay off the bed to the length required to sow the quantity, and if we mean to sow birch-seed at the same time, we generally find that one bed, taken from side to side of the compartment, is enough for the sowing of the seeds of both these sorts. This arranged, then, the ground dug very finely, and reduced to a still finer state with the rake, and the bed laid off 4 feet broad, by having an alley run up each side of it—say 12 inches broad—a thin shovelling of some 2 inches is taken from the alleys with the spade, in a regular manner, from end to end, and spread from both sides over the bed lying betwixt as evenly and equally as possible; so that, when the bed is thus shaped, it will present a regular flat table, nearly 4 inches above the level of the bottoms of the alleys. After the earth has been added to the bed from the alleys, we next rake the surface to a very fine texture, bringing all stones and rough particles into the alleys from either side; and after we have its surface reduced to as fine a mould as possible, we give it a regular but not heavy beating with the back of the spade, or pass a light roller over it, so as to render the whole surface as even as possible. We next sow the seeds, and have them covered to the desired depth with the finest mould, previously prepared by passing it through a sieve. After this mould is laid on—and it should be laid on very evenly and equally—the surface of the bed should be smoothed, either with the back of the spade or by passing a light roller over it, so as to make the particles lie close together, and thereby prevent the drought from taking effect upon the seed; and this done, the edges of the bed should be properly lined off, and the rough particles removed from the alleys.

1746. With regard to the sowing of the birch-seed, we need only state that it is to be dealt with in every respect as has been advised in regard to that of the alder. As the seed, however, is very small, and a considerable proportion of it generally abortive, it should be sown rather thickly—say 200 to the square foot; and as it is easily rotted if too deeply covered, care must be taken not to overdo it in this respect. In short, the slightest covering of the very finest earth is sufficient for the seeds. This requires to be put on very equally all over, and should not be disturbed with the rake, but only have a smooth with the back of the spade, or a light roller passed over it.

1747. The horse-chestnut, the sweet chestnut, and the walnut, are to be sown in every respect as has been described in reference to the oak.

1748. The Norway maple and sycamore are also sown on the surface of the ground, in rows 15 inches apart, and at the rate of one seed to the 3 square inches, but they are only covered to the depth of three-fourths of an inch.

1749. The seed of the holly, after having been rotted in a heap mixed with sand, or any fine earth, for a period of fifteen or sixteen months, should be sown in beds in the month of March. The surface of the bed should be smoothed with the back of the spade before the seeds are laid upon it; after they have been sown they should be covered with about half an inch of the earth from the alleys. The earth should be made moderately fine for the covering of this class of seeds, and should be laid on equally and evenly; and it is an improvement to pass a light roller over the bed when finished, in order to prevent too sudden drying of the earth on the surface. In sowing the holly-seeds, as they are mixed with sand, the better way is, as they cannot be well separated, to sow both together, and in allowing the quantity of seed, to make an allowance at the same time for the sand amongst it. The seed seldom or ever comes all up in one year, but continues to come up for two successive years.

1750. The sowing of the haws, or seeds of the thorn, is dealt with in every respect as recommended for that of the holly.

1751. For the manner of collecting the seeds of the Scots pine, larch, Norway spruce fir, silver fir, and pinaster, and for the way in which we go to work in the sowing of it in the nursery, we have to refer to the remarks made on this subject in that part of the Ninth Chapter of this work where special reference is made to these trees.

1752. In sowing the seeds of the different trees referred to, special care should be taken not to do this but in dry weather, as if the work should be attempted at any time when the particles of the earth readily adhere by any slight pressure, it would, from this cause, injure the vitality of the seeds, and prevent a large portion of them from vegetating. We have to recommend, therefore, that the work of sowing should never be undertaken till after some days of dry weather, and when the rake can be used freely without any of the earth adhering to it.

1753. As it is desirable to make the ground very fine, as a preparation for the sowing of all the smaller seeds, and especially for those of the pine and larch, all the three different-sized rakes formerly referred to should be used for this purpose, and should be kept in operation as the men turn over the ground with their spades. The method of using the rakes to bring the ground to a very fine surface for the sowing of the smaller seeds is this: the men who are employed to dig begin each at the same end of the opening, and continue digging to the other end; and they proceed in a regular manner one after the other, each turning over to the other side of the opening before him about 5 inches of the solid ground on which he stands. These are followed, first by a man with what is termed the *harrow rake*, being a large rake with its teeth 4 inches long and 3 inches apart: with this he breaks thoroughly the earth as it is turned over by the men with the spades. He, again, is followed by another man with a rake, having its teeth 3 inches long and 2 inches apart, and with this he rakes the same earth which has already been raked by the large rake before him; and the third follows the other two with a smaller rake than that which the man before him has—generally the teeth are 1 inch apart, and 1½ inch long. The men proceed digging and raking in this way, one party following the other from side to side, till all the ground to be used has been subjected to the operation, and as each raker proceeds, he clears the ground from all stones, &c., that he can lay hold on with his rake, and draws them down into the opening, so that the third rake makes the land pretty fine. But, besides this, if it should be found necessary to make the ground very ine, a fourth man, with a still finer rake, is made to follow, so that in his way the land intended to be sown may be brought to any state of fineness by the use of rakes of different sizes. If, however, in the act of digging and raking, the land be found to adhere to the tools, it is an indication that it is not in a fit state for the operation, which should therefore be given up till the ground be found so dry that the rakes can be used cleanly. While the weather continues good and favourable for the purpose, no time should be lost in having the seeds committed to the earth; and in order to facilitate this, another party of men should follow those employed in the preparation of the ground, who should prepare the beds, sow the seeds, and cover them, so that by this simultaneous process no time is lost by bad weather intervening betwixt the time of preparing the ground and having it sown, which is always a great advantage in work of this kind, more especially as, when the ground has been made so fine as we describe, it is long in becoming sufficiently dry should wet weather come on.

1754. We now come to take up the subject of manures for the nursery, for which, according to the diagram, a portion of ground has been allowed, extending to 1 rood 20 poles, and numbered on the diagram as compartment 9. The object of devoting a part of the nursery-ground to this purpose is, that all weeds, &c., may be collected and put upon it in heaps to rot, and that leaves and all other waste vegetable substances may be also collected and brought to it, there to rot and be mixed up with lime and new earth for being afterwards laid on the land as manure.

1755. It must be kept specially in view, that land kept as a nursery for the rearing of young forest-trees must upon no account be kept up in a highly manured state, as, if so, such an undue excitement is given to the young plants as causes them, when removed from it to a poorer soil, to become stunted and unhealthy for some years afterwards, giving rise to disease in the subjects, weakening their constitutions, and impairing their value as timber crops. This state of things will therefore be avoided by every intelligent forester who wishes to excel in his profession and to do justice to his employer. We have therefore to recommend that after the new nursery shall have got one fair manuring with farm manure—which it generally requires at first when the land is newly trenched and taken in, as in this state there seldom exists much vegetable matter in the newly-turned-up earth—it should afterwards be manured chiefly with *road-scrapings, lime-rubbish,* or a small quantity of *lime itself,* mixed with well-rotted weeds, leaves of trees, or turf, and fresh soil carted from old fences or the boundaries of fields. In short, after the nursery-ground has got one dose of farmyard manure, in order to enrich the inorganic parts, the only manure used should be such as we have just stated. In order to grow green crop sufficiently good on land of this description, on which little farmyard manure is laid, it is only necessary to apply bone-dust, or any other of the artificial manures in general use; and in all cases the leaves of the green crop should be left on such of the compartments of the nursery as are just cleared of it. Attention should therefore be paid to keep a large store of such earths and rotted vegetable substances in the manure compartment, and to see that, as the properly prepared portions are laid on the land, fresh quantities are collected for successive use.

1756. The two compartments Nos. 10, 10, together with the two borders Nos. 10, 10, extending in all to about 7 acres—on which it is intended that the seedlings from the present year's sowing should be planted next year, and on part of them the tree seeds be also sown next year, as they are not required to be used for any nursery crop till the following winter and spring—should for the summer be sown with any grain crop that may be considered best for the district, as by doing this a remunerative return will be got from the ground while it necessarily lies unoccupied by any other crop. By taking a cereal crop from this portion of the land, it will not be the less fitted to receive the rotation of young trees afterwards, as it can be dug over in the month of September or October, immediately after the crop has been harvested from it, which will cause the stubble to rot, and improve the land before the seedlings are planted on it.

1757. On the border No. 11, as indicated on the diagram, it is intended hollies and thorns should be planted for hedges. Under paragraph 1705 it will be seen that we have made allowance for 2000 hollies and 12,000 thorns. These, then, we propose, should be planted on the border marked No. 11. In planting the hollies, the work is performed in the same way as has been described in regard to the other seedlings, and they may be put in 4 inches apart in the rows, and at the distance of 15 inches, row from row; and the thorns may be planted similarly. The hollies should be well watered at the roots as they are planted, as they are very apt to suffer from removal in dry weather: our own plan is to remove them on a wet day in the month of May, just when they are beginning to show growth; by adopting this mode, we have been very successful in the operation.

1758. Border No. 12, as indicated on the diagram, we propose should be devoted to such plants as have to be wrought by layering and engrafting, such as the lime-tree and English elm of the former class, and the varieties of the holly, beech, ash, sycamore, and elm, of the latter. In the statement under paragraph 1705, 200 lime-trees have been allowed for the purpose of layering on the border under notice; and if it should be wished to rear the English elm also, an equal number of these may be bought in for the purpose. For the mode of planting these in the nursery-ground, and for that of propagating plants from them by layering, see the remarks and recommendations on the subject in Chapter VIII., on the propagation of the English elm.

1759. As to the mode of extending a variety of any plant or tree by engrafting, it would be superfluous to make any comment on the subject, as we are well aware, from our own experience, that no written description we could possibly give could enable a man to do such a fine piece of work so satisfactorily as to answer the end in view. We have never known a man who could successfully do the work of engrafting who had not spent a considerable time in performing it under the eye of an experienced operator. It is not so much the mind that has to be taught on the subject as the hand. As well may we expect that an artist could make a good woodcut by reading a description of the operation, without having his hand exercised in it, as that a man could engraft from a written description without his hand being taught by practice. We would therefore recommend that any man who wishes to become a successful engrafter, should attend for one season in a public nursery, where the art is necessarily carried to the highest perfection, and where there are men capable of giving more instruction in one day on the subject, simply by teaching the hand how to operate on the subjects, than could be given by writing a volume on it: he will find his time well spent. In short, there is no other way of really acquiring the art. On borders Nos. 11 and 12, besides the plants for hedging, and the plants for layering and engrafting, there may be planted evergreens of sorts, as well as specimens of the various new sorts of coniferæ, and also cuttings of various plants that may be wanted.

1760. We have now described generally the mode of planting and sowing the nursery-ground the first year; and after the works described have been all completed—and they should be so by the end of May—it will only be necessary to keep the planted ground and seed-beds clean from weeds all the summer afterwards. In doing this, especial care will have to be exercised by the forester to destroy weeds among the planted trees with the hoe in dry weather before they grow to any considerable size, as, if left till strong, the work will become costly, and more difficult to perform. In keeping the seed-beds clean from weeds, the work should be done as much as possible in damp and cloudy weather, and the weeds should be removed as soon as they rise above the surface, and before they attain any degree of strength; as, if they are removed in strong sunshine, the earth will be so loosened about the plants as to admit of drought injuring their roots; and if the weeds are allowed to get strong, they cannot be removed without pulling up with them large quantities of the young trees.

1761. At this stage of our remarks on the management of the nursery, it falls that we should bring up an account of the expenditure that has been made upon it up to the end of the second year, which we shall suppose to be the end of November. In all probability it will stand as under:—

Sum outstanding on nursery at the end of the first year, and as particularised under paragraph 1698, . . .		£736 9 0
To making, say 2000 yards of roads and walks at 1s. per yard,		100 0 0
„ 24,000 privet plants for sides of walks, at 15s. per 1000,		18 0 0
„ cost of young trees bought in for the nursery, as per statement, paragraph 1705, ...		633 16 5
„ supposed cost of tree seeds, as per paragraph 1706, . .		20 0 0
„ planting 2,340,900 plants, as detailed under paragraph 1705, say at 1s. per 1000 over all, ...		117 9 10
„ expense of sowing tree seeds, as per statement under paragraph 1706, say in all		10 0 0
„ keeping clean nursery for one summer, . . .		85 0 0
„ expense of collecting manures, ...		10 0 0
„ corn seed for sowing 7 acres of compartments No. 10, .		8 0 0
„ rent of 26 acres of nursery-ground for two years, say at 30s. per acre, ...		78 0 0
„ interest on rent for the first year, and which was not entered into the former account of expenses, at 5 per cent,		1 19 0
„ Do. on sum outstanding at the end of the former year, at 5 per cent, ...		36 16 0
		1855 10 3
Deduct from this value of grain crop on 7 acres of No. 10, say at £10 per acre, ...	£70 0 0	
Do. value of 59,000 hardwoods, now supposed to be ready to plant out, at 30s. per 1000, .	88 10 0	
Deduct value of 780,000 2-year seedlings, one year transplanted larch, now ready to go out, say at 20s. per 1000, ...	780 0 0	
Do. value of 300,000 2-year seedling pine, one year transplanted, at 10s. per 1000, . .	150 0 0	
		1088 10 0
Sum outstanding at the end of the second year of the nursery, or say at November 1880, ...		£767 0 3

1762. From the foregoing statement—and it may be taken as pretty near the truth, as it is founded on our experience in similar cases—it will be seen that the entire sum outstanding on the establishment at the end of the second year is £767, 0s. 3d., after deducting the value of the crops ready to be removed from it, and leaving in the nursery all the other transplanted trees, as well as the seedlings that will now fall to be accounted for, which it is understood will have grown on compartment No. 8. In fact, were the whole stock of such an establishment to be sold, even at the time now referred to—at the end of the second year of its establishment—we have no doubt it would pay the proprietor all the outlay made on it. This of itself is an encouragement to extensive landed proprietors, who intend planting largely, to avail themselves of rearing their stock of plants on their own estates. But this is not all the advantage to be derived from such an establishment. It is a well-known fact, that trees nursed and grown upon a district are always more certain to succeed well than when grown upon a distant part of the county, and brought in for planting.

1763. The same modes of the different operations of planting and sowing in the nursery are continued year after year successively, as long as trees are wanted to supply the demand for planting out upon the forest lands. Supposing that the hardwoods have been cleared, during the winter of 1882, from compartment No. 3, the larch from those numbered 5, 5, 5, and the Scots pine from the one numbered 7, and all planted out into the enclosures suited for them—giving in all 7 acres 1 rood cleared of the nursery-ground—this extent is to be again put under green crop the spring following, or in the summer of 1883, preparative for being again planted with the same sorts of trees the year after, or in 1884; while, on the other hand, the five compartments numbered 10 are to be planted with the young seedlings that are now supposed to be raised on compartment No. 8, in the spring of 1882, in every respect in the same proportions and in the same way as has been already described for the different sorts; and the seeds for crop 1882 may be sown in any part of compartment No. 10 that may be considered convenient for the purpose. In planting and sowing, attention should always be had to the proper subdividing of the compartments, as, if this be not attended to, the business of the nursery would become much confused. We need hardly make the remark, as it seems evident at a glance at the diagram that the hardwoods on compartment No. 2 are to go out in the autumn of 1882, and the larch and pine on compartments 4 and 6 as well; and that in this way, and from the planting out of the requisite number of seedlings of each kind each year, the regularity of the supply is proposed to be kept up, the one crop succeeding the other.

1764. Having now stated all that we think necessary to say on the subject of nursery management—and these remarks on it are merely meant for the guidance of private foresters, and not to instruct public nurserymen in their profession—we shall conclude by giving a few general suggestions on the head.

1st. The regular rotation of the crops should be paid especial attention to, as, if not, and two successive crops of trees are taken from the same compartment without a green crop intervening, the trees of the second crop would be much inferior, not only in appearance, but in vigour of natural constitution. As the different classes of young trees are ready to go out, the land from which they have just been cleared should be subjected to a deep digging, and put under green crop the summer afterwards, preparative to being planted again the next year.

2d. The portion which is intended to be sown with the tree seeds should be deeply dug the autumn before, and allowed to lie exposed to the action of the weather till spring, when it will have become much improved and in better condition for the healthy vegetation of the seeds.

3d. The workpeople, in cleaning betwixt the rows of young trees, are very apt to injure the stems with their hoes and rakes. The forester should therefore see that the rows are not planted closer than has been specified, and that the people who may be employed in the cleaning are careful not to injure any of the trees in the way stated.

4th. In the lifting of the different crops of young trees from the nursery, the greatest care should be taken to do so with all their fibres uninjured, and rather with a small portion of the soil attached to them than otherwise. No shaking and tossing about of the plants should be allowed as they are lifted, as such usage always tends to injure their vitality, and consequently their growth afterwards.

5th. The plants should not be lifted from the compartments in large quantities at once, but only as they are required for planting out, as when they lie long in the sheugh their fibres become injured; and in removing the plants from the nursery to the forest or plantations, they should be tied up in convenient bundles, and stowed carefully in hampers or mats, out of which they should be emptied after being carried to the ground on which they are to be planted.

SECTION III.—HOW TO CHOOSE YOUNG FOREST-TREES WHEN BUYING THEM FROM PUBLIC NURSERIES.

1765. Every proprietor who has occasion to plant forest-trees to any considerable extent, unless he have a sufficiently large nursery of his own, will find it necessary to supply himself from some respectable nurseryman. In doing so, it is absolutely necessary that healthy trees should be selected; and also those of such a nature as may be suited to the situation where they are intended to be planted for good and all.

The proprietor who intends to plant should either himself visit, or cause his forester to visit, during the summer previous to the planting season, any nursery from which he intends to purchase his supply of young forest-trees, and see that the stock of young trees in it is in a clean healthy state, free from all disease and insects, and of a strong and robust character.

Such a visit in the summer season may by many be considered unnecessary, but every experienced planter can bear witness to the propriety of it. We have known instances of diseased trees from a nursery being the cause of propagating the same disease through several plantations in the neighbourhood. In asserting this, however, we do not mean to say that any respectable nurseryman would be guilty of sending diseased trees to any of his customers; but we say that every planter or forester should, previous to making a purchase, go and visit the nursery-grounds, and judge for himself as to whether he shall buy or not. The proper time for such a visit is during the month of July or August, when the trees are in full leaf, and most of them still in a state of growth.

In these months, all young trees should have the bark upon the main stem, and branches clean and free from any appearance of *scale* or *bug*; and when a little of the surface skin is removed by the nail of the thumb, the bark underneath should be of a pure, healthy, transparent green colour. The surface bark of a young tree in perfect health should be easily removed from the inner bark.

1766. Having visited the public nursery-grounds in the month of July, and found the general health of the young trees quite satisfactory, it will be necessary for the intending planter again to visit the same grounds about the middle of October or first week of November, in order to make purchase of such trees as he may require for the season. In making purchase, it is absolutely necessary to bear in mind the nature of the ground and situation to be planted. If the ground is a thin soil upon a high situation, then choose trees from the nursery that have stood rather wide in the rows, and have had free air and room, and are rather of a low-set bushy character, and altogether presenting a hardy appearance: plants of such a character will suffer very little indeed from being removed to a high climate. For a high situation, always choose one year's transplanted pine, larch, and fir, and hardwood not exceeding 2 feet in height. If plants of an opposite character be chosen for such a situation—that is, tall slender plants, which have made long shoots of young wood the previous summer—they will be sure to suffer, and it is more than probable than many of them will die.

1767. If the situation to be planted is a low sheltered one, with a good soil, then choose somewhat tall well-grown plants for it, for in such situations there is generally a luxuriant growth of the natural grasses; and unless the young trees be pretty tall, they would be altogether choked by such a mass of herbage surrounding them. Above all, it is necessary to be most particular in seeing that the young trees chosen be well rooted—that is, having plenty of small fibrous roots, which are the mouths by which the plant derives its nourishment from the earth. In a rather light soil, not too highly manured, the roots of young trees are generally good; but if the young trees have grown in a stiff heavy soil, there is a risk of their being badly rooted; that is to say, they will most likely have few small fibres; and young trees with few fibres never succeed well when replanted—more especially those of the coniferous tribe. Much of the success in the growing of trees in the forest depends upon a good healthy choice from the nursery; therefore this point should always be carefully attended to by every intelligent planter.

1768. No proprietor should grudge to give a fair price to a respectable nurseryman, in order to have his orders punctually and faithfully attended to. The gentleman who offers a fair price is always sure to have a good article sent him; while, when a proprietor offers a low price to any nurseryman for his trees, the nurseryman is not enabled to bestow that labour upon the lifting of the young trees which is necessary to secure the safety of the roots. Trees of the pine tribe, if they are lifted out of the earth carelessly, generally lose a large portion of their roots; and in such a case the trees cannot grow. Therefore every planter ought to see that the trees he uses are carefully lifted from the nursery-ground.

1769. In purchasing the rarer sorts of coniferous trees from public nurseries, foresters should be very careful to see that they have not been tenderly reared in pits or frames; as if so, they will have small chance to succeed when planted out, even on a moderately sheltered part. All plants of this class should have stood at least two years in the open grounds of the nursery before they are sent out to the country; and the forester should be careful to see to this, otherwise he will run the risk of losing the subjects.

SECTION IV.—FORESTERS WHO PURCHASE YOUNG FOREST-TREES FROM PUBLIC NURSERIES SHOULD THEMSELVES GO TO THE NURSERIES AND SUPERINTEND THE LIFTING AND PACKING OF THEM.

1770. It generally happens that nurserymen who have a good standing in respect to the rearing of young forest-trees, and who really have them in all respects healthy and suitable for successful planting out on forest land, have a great pressure of business on their hands in the planting season, and are therefore often unable to attend personally to all the orders they obtain for their stock, however anxious they may be to do so. A large number of orders for young forest-trees come into the hands of a first-class nurseryman—say, in the month of November—and if the weather at that time is favourable, a considerable portion of them is executed; but frost sets in, and a fall of snow takes place, which puts a stop to all outdoor nursery operations, while a large proportion of the orders received are still to attend to. Those of course must lie over till a return of favourable weather, and in the meantime other orders accumulate from all parts of the country, with instructions to *forward as soon as weather will permit;* so that by the time the weather has become suitable for again lifting young trees from the ground, some hundreds of orders for them are to be attended to, while there may not be more than three or four men in the establishment capable of superintending the lifting of the orders wanted, and in consequence the head of the establishment can only do the best he can for his customers, and must either have time to get the plants carefully and satisfactorily lifted, or lift them hurriedly, and therefore in a condition generally unsatisfactory to all concerned.

1771. The statements given in the last paragraph are based on our own experience in the capacity both as nurserymen and as foresters; for, as nurserymen, we have often been obliged to inform some of those who ordered plants from us that, from pressure of business, we could not possibly supply them within a given time, and, in consequence, they got their plants elsewhere; while, as foresters, we have invariably gone direct to the nursery from which we wished to purchase, and had our plants lifted under our own superintendence, and removed before leaving the ground. In taking this course, we had workmen put under our superintendence for the time by the head of the establishment, and in this way we had all the young trees we wanted lifted and packed to our entire satisfaction, and that without disturbing the head of the establishment, who was engaged in lifting orders for other parties.

1772. We have never found any nurseryman of good standing object to intelligent foresters coming to their grounds to superintend the lifting of the trees they might want; but, on the contrary, we have invariably found them grateful for the assistance thus rendered them in the pressing season of their business: for it is not the want of common labourers that prevents nurserymen from getting their orders executed in time to suit their customers, but the scarcity of men qualified and trustworthy enough to superintend the works of lifting and otherwise attending to their orders.

1773. In the pressing season of lifting orders of young trees in nurseries, we have very often had occasion to observe a squad of men —common labourers—engaged without a proper and responsible leader, lifting an order of forest-trees, which had to be sent off by rail the same evening. In such cases the plants were not sufficiently loosened by the men with the spades, before those who followed pulled them up from the earth, and in consequence a large proportion of the fibres were broken off in the act of pulling. This of itself was highly objectionable; but, besides, after the plants had been tied up into bundles, their roots were allowed to lie exposed to the frosty air and drying influence of the sun for a few hours, thus drawing out the vitality of the plants, and rendering them, to a large extent, unfit for successful transplanting on the forest land. Now, the cause of this state of things was the pressure of business at the time on the hands of the nurseryman and his assistants, whereby they were obliged to either trust the lifting of certain orders to common labourers, or refuse to have them lifted at all till such time as the work could be properly gone about under their own superintendence.

1774. For the reasons stated above, we recommend that every forester who may purchase young trees from public nurseries, if he wish to be really successful in his planting operations, should make it a rule to attend at the nursery himself, and either see his plants properly dealt with by others, or superintend the lifting of them himself, as the state of matters may suggest in the nursery at the time. Many foresters are quite unacquainted with the hurried state of business that often takes place in public nurseries during the planting season, and especially as spring advances, and they simply trust that their young trees will be in all respects properly dealt with; but it often happens that a month or two after planting they find a large proportion of their young trees have either died or look sickly, and they are not able to account for such a state of things. Then, we say to all who meet with such disappointments, attend to see your trees lifted, and you will not have to mourn over disappointments of such a nature.

CHAPTER XIII.

SECTION I.—THE NATURE AND PRACTICE OF PRUNING HARDWOODED TREES.

1775. Many conflicting opinions relative to the pruning of forest-trees still prevail among those who profess the art, which opinions, we believe, have more a tendency to darken the point referred to, than to throw light on it. All this diversity of opinion arises from the want of a properly extended knowledge of the science of vegetable physiology in the case of those who generally practise pruning, and from a proper application of it to the subject in question. Now, the only way reasonably to confirm the mind upon this important point is, not to lay any particular stress upon any particular example that may be given, but to examine the true nature of the art of pruning, and the tendency it has to improve or retard the healthy development of trees in various situations. In short, in order to a right understanding of the nature of pruning as applied to forest trees, attention must be paid to its effects upon trees under every variety of circumstances. We consider it proper that every proprietor of plantations should be able to judge for himself in the matter of pruning, and to detect proper from improper pruning. And to this end we shall enter minutely into detail under this head, and give a distinct statement of our reasons for doing it in one case and not in another. But before doing this, it will, we think, be proper first to examine the effects that the amputation of a branch from a tree has upon its constitution: such previous knowledge will prepare the mind for a better understanding of the true nature of pruning as it is generally practised among intelligent foresters.

1776. A tree, through the agency of its roots, draws nourishment from the earth into which these enter, chiefly in a state of solution in water; which liquid nourishment, or, as it is generally termed, the sap, ascends the trunk through the longitudinal vessels or pores, from which again each branch or limb of the tree is supplied in succession. The body or trunk of a tree forms one bundle of longitudinal tubes, through which the sap ascends from the roots to the branches. From this bundle each separate branch is supplied by its own separate line of tubes; or, which is the same thing, each particular root of a tree has to draw nourishment from the soil to supply its own particular branch; and the communication between these two points is maintained by a particular set of vessels in the trunk of the tree. The watery part of the sap, when it ascends into the leaves, is for the most part given off by them in the form of perspiration; that which remains at this point undergoes a change previous to its descent in the form of proper woody matter, which change is effected by the leaves inhaling *carbonic acid* and other gases, which enter into the composition of the returning sap; and in this manner there is a continual circulation of the sap in the tree—the roots drawing in and supplying the whole with moisture, which, when it is raised to the leaves, undergoes a chemical change, and is returned in the form of proper woody matter. The practical deduction to be drawn from this is, that every branch growing out of the main body of a tree is by nature meant to act as a laboratory, in which woody matter is prepared, and returned for the joint supply of itself and the body of the tree. From this we are bound to conclude, that when we cut a branch from a tree, we take away from it the means of supplying it with a certain proportion of woody matter for its enlargement; and this is, indeed, the case with pruning in all cases of the operation. But under skilful management in pruning, this depriving of a tree of its due means of nourishment is only temporary, as in a short time after the operation has been properly done, and when the tree operated upon has had its growth properly directed, the increase of timber is at once remarkable, as compared with others of the like nature and age which had not been pruned, or with others which had been unscientifically managed.

1777. When a large branch is cut off immediately from the body or trunk of a large tree, the usual sap which supplied it in its ascent from the roots will be stopped short, and for a time will ooze out at the cut part. In a short time, however, the sap, as it rises in those vessels of the trunk which formerly supplied the branch taken off, becomes stagnated, and causes rot in that part, which can never be the case while the branch remains to draw up and prepare the sap in its leaves; and this is the case in all instances of large branches cut from large trees. But in the case of a branch being thus cut from a young sapling in a rapidly-growing state, the tree is not injured, but improved—the sap of the plant being in such a vigorous state that rot cannot take place. Now, the practical deduction to be drawn from this is, that the amputation of a large branch immediately from the body of a large tree, instead of being favourable to its health and value as timber, has quite the contrary effect. We say immediately from the body of the tree, because the cutting off of a part of a branch is by no means injurious to the health of a tree; but, on the contrary, when part of a large branch is cut off, the flow of sap to that part is checked, and the body or trunk of the tree is in proportion enlarged.

1778. In Professor Lindley's 'Theory and Practice of Horticulture' there are some paragraphs so much to the point on this subject, that we think it right to bring them under the notice of the forester here. In the work referred to the Doctor states: "The quantity of timber that a tree forms, the amount and quality of its secretions, the brilliancy of its colours, the size of its flowers, and, in short, its whole beauty, depend upon the action of its branches and leaves, and their healthiness. The object of the pruner is to diminish the number of leaves and branches, whence it may be at once understood how delicate are the operations he has to practise, and how thorough a knowledge he ought to possess of all the laws which regulate the action of the organs of vegetation. If well directed, pruning is one of the most useful, and, if ill directed, it is among the most mischievous, operations that can take place upon a plant. The object of pruning is either to influence the production of flowers and fruit, or to augment the quantity of timber."

"Pruning is nothing less than the removal of leaves. To cut off a branch in summer is evidently so; and if the branch is naked, still its removal is the destruction of the part from which leaves would have been produced had it been permitted to remain."

"Prune not at all, should therefore be the maxim of the forester. Plant thickly, thin constantly, stop carefully, and leave the rest to nature. But, unfortunately, it does not happen that he who plants well always thins constantly; it is still more rare that stopping is thought of; and so a maxim, one of the soundest in the whole system of forestry, cannot be observed. Hence pruning may be regarded as a necessary evil, to which the wise must submit because of the ignorant; the careful to cure the evils inflicted by the careless."

1779. During our practice as a forester we have had extensive opportunity of observing the nature and quality of full-grown timber as it has been affected by different kinds of management in the way of pruning. Having seen much timber of all ages cut up for different purposes at saw-mills, we have had occasion invariably to observe a practical truth, that wherever branches 4 inches and upwards in diameter at their base had been cut from the trunk of the tree, the wood for a considerable way under that part which had been so pruned was discoloured and worthless. Where much cutting of large branches had taken place in one individual tree, we have always found such a tree to be scarcely fit for any valuable purpose whatever when it came to be cut up. Where the pruning had been done a considerable number of years before the tree was cut down for use, the wounds upon the surface were not easily observable,—in fact, such trees often appear sound to outward appearance; but when the bark and outer covering of sapwood are removed, the pruned part is at once observable, and the vessels leading from it down to the roots are generally found soft and of a dark colour.

1780. Having now pointed out the effects the amputation of a branch from the trunk of a tree has upon its constitution, we next proceed to detail the method which ought to be practised with pruning operations in all cases. And in order to a right understanding of this most important point in arboriculture, we shall bring under consideration the pruning of trees, from the time they are planted out from the nursery to that of their being so fully developed as to be beyond any advantages that could accrue to them in respect to pruning. It may not be out of place to remark here that, generally speaking, wherever healthy young trees have been properly planted in a suitable soil and situation, little or no pruning is ever found necessary; as in such a case the trees grow vigorously upwards, with perfect leaders in each case and comparatively small branches. Where pruning proves necessary, it is generally found that the soil is not of the description nor in the condition necessary for the healthy growth of the species; for in all such cases the trees do not come away with vigour upwards, but become branchy and spreading in their habit. Indeed, wherever we see much need for pruning on young trees, we conclude that the cause lies in the bad management of the planter in the first instance. Pruning therefore is, generally speaking, only necessary after unskilful planting, as where the trees are planted on a soil in all respects favourable to their growth, pruning is never found necessary to any important extent.

1781. Many foresters are in the habit of closely pruning all young hardwood trees, particularly elms and oaks, when they are newly taken from the nursery-grounds, and preparatory to planting them out in the forest; which close pruning is most injurious to the health of all young trees when newly lifted from the ground. The system generally practised by foresters in this case is, to cut off clean to the main stem all strong branches, and only leave a few small twigs near the top of the plant, with the view of drawing up the sap. The natural consequences of such a cutting off of all the stronger branches from a young tree are that, when the sap ascends in the plant in the spring, it is arrested at the wound where the first or lowest branch was taken off, and escapes from the cut part by evaporation. It being thus arrested, there is a natural effort made by the plant to produce young shoots and leaves at this point, in order to convert the sap into proper woody matter; consequently, we almost always find a few young shoots made the first season immediately under the part where the lower strong branch was taken from the plant, while all the rest of the young tree above this growth of young shoots remains dry, and very frequently dies—the sap not rising sufficiently to carry on life above the part where the new shoots spring out. Even if the sap should not be all arrested at the point referred to, the part above it remains in a sickly and unhealthy state; while the young shoots produced lower down draw all the nourishment to themselves, and ultimately form a distorted unshapely plant, unless it be carefully attended to by giving some one of the shoots the preference, and cutting away all the rest, allowing it to become the top.

1782. The proper manner of proceeding with the pruning of forest-trees, as they are newly lifted from the nursery, and preparatory to planting them out, is to *shorten* all the *larger branches* that have the appearance of gaining strength upon the top or leading shoot of the young tree. This shortening of the larger branches ought to be done in such a manner as to leave only from one-half to two-thirds of their whole length remaining, with, if possible, a few small twigs upon each, in order the more readily to elaborate the sap as it rises in the spring; and in this state the young trees may be planted with the greatest assurance of success. The great advantage of this method of pruning young trees is, that when the sap rises in them, the first summer after planting, there being a regular supply of small proportionable branches along the main stem, leaves are formed, and sap is drawn up regularly to every part of the tree, consequently the tree maintains an equal vigour throughout. Were all the branches left upon the young trees, the roots, from the effects of removal, would not be able to supply the whole with due nourishment; and the consequence would very likely be, that the plants would generally be much checked in their growth for the first season or two, and that some of them would die down to the ground-level, from which part of the trees numerous young shoots would issue, much in the same manner as they do from the cut part of those trees which have been over-pruned.

1783. It is now a well-ascertained truth among all practical foresters, that when a young tree is in a vigorous state of growth, and the wood full of sap, previous to its having made any heartwood, any branch may be taken off without doing the least injury to it. It is, therefore, just at this stage of the existence of a tree that it can with certainty be made to do well, or otherwise, according as it is attended to—to give the top the lead in the growth—to check the stronger branches—and to give the tree that shape it may be desired it should have when it attains full age.

1784. When young hardwood trees have been pruned in the manner above recommended, and after they have been planted and grown in their permanent situation for the space of three or four years, they will by that time have established themselves properly in the ground; which circumstance is known by their putting forth considerable shoots of young wood. At this stage of their growth it will be necessary to go over them all with the pocket pruning-knife, and cut close to the main stem or trunk all the parts of the branches that were formerly shortened, and, at the same time, to shorten back all other branches that may have gained strength, or may have the appearance of gaining strength, upon the top or main shoot. But it should be particularly observed, that this pruning ought never to be allowed to be done until the young trees have decidedly established themselves in the ground, and are in a vigorous healthy state of growth. At the same time, any unhealthy plant which may not have succeeded well should be cut over, when it will soon rise up with renewed vigour.

1785. We have now given a statement of the manner of proceeding with pruning operations in the case of young trees about to be planted out into the forest; and also the treatment they ought to receive after being three or four years established in the ground. There may, however, be—and, indeed, too often are—cases where hardwood trees, while young, have been entirely neglected. It will now be proper to consider the treatment that such ought to receive. We shall first suppose that we have to do with a plantation of young hardwood trees which had received no pruning at all previous to being planted; and we shall further suppose that the trees are oaks, and of five or six years' standing in the forest-grounds. On examining the state of young hardwood trees of this description, it will be observed, if the situation be an exposed one, that many of them have died down to the part resting upon the surface of the ground, and that from this part a number of branches have issued, each contending for the lead in the growth. In such a case as this, no time should be lost in giving the strongest and most healthy shoot the preference, and cutting away all the rest, as well as the dead part of the tree, nearly by the ground, or at least down to the part where the young shoots issue. Prune the shoot intended to be left for the future tree by shortening all the stronger branches, and taking off clean to the stem any that may be considered superfluous; and in this manner go over every young tree in the plantation, always choosing the most healthy shoot for the future tree, and one which appears to have naturally a good balance of branches, with the leader or top shoot strong in proportion to the rest.

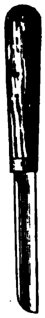
1786. We shall again suppose a plantation of oaks, of the same age as the one above alluded to, but the trees in which, instead of having been planted without pruning, have been pruned too severely when lifted from the nursery-ground, and previous to being planted. The treatment in this case must in every respect be the same as the former—that is, all the dead wood should be cut away immediately above the point from which the young shoots issue; and the strongest and most healthy shoot being fixed upon for the future tree, it must be properly pruned in the way that has been stated in the foregoing paragraph. But in a case of this nature, where the trees had been overpruned previous to their being planted, there is often more difficulty in making choice of a good young shoot than where no pruning at all had taken place. This arises from the young shoots springing from the main stem in a horizontal manner, and that, too, very often a considerable way up the stem. In a case of this nature, where a proper leading-shoot, rising perpendicularly, cannot be got, the only way, and the method we always follow, is to cut the main stem by the surface of the ground, and allow a set of new shoots to rise up. The chance generally is, that when the tree is thus cut down all the new shoots will rise in an upright position, and a choice can be afterwards made: but wherever a proper leading-shoot can be had, let it be chosen, although it come away rather far up upon the stem. If it rise perpendicularly, and the plant be in a vigorous healthy state of growth, it will succeed well and form a perfect tree. This sort of work should be done in the spring months, so that the growth may set in immediately after the operation is performed.

1787. With regard to the pruning of forest-trees generally, all would be simple and well, provided a distinct practical rule were attended to, both by proprietors and foresters, for the rearing up of plantations at every stage of their growth; but in practice the case is almost always the contrary. No distinct practical rules being adhered to among foresters as a body, one goes to work in one way, and another in a contrary way, in the same piece of work; and in the manner of doing the work all depends upon the knowledge and practical experience of the man. A man of high intelligence in his profession, and of sound practical experience, finds out for himself what ought to be done, and guides himself in the execution of his work accordingly; but the man of small knowledge and experience, unless he has some definite rule laid down to guide him, will go to work merely under the direction of his own judgment, whether that may be right or wrong.

1788. The only sensible rule that can be laid down for general guidance in regard to pruning is, to begin the operation on the trees at an early stage of their growth, and to look over them frequently —say once in every two or three years—paying particular attention at each time to direct the complete ascending of the leading or top shoot by shortening any branches that seem to be gaining strength upon it, and at the same time attending to shorten any branch that may be gaining an undue strength in proportion to the others on the same tree. If young hardwood trees are kept moderately close among their nurses in a plantation, the side-branches will not grow of great strength, and these may be gradually removed from the lower part of the stems without doing the trees any injury; on the contrary, the operation will be beneficial to their health, and cause them to form clean stems for the after-produce of useful timber. In no case, however, should the stems be cleaned of branches beyond one-third of the entire height of the tree at any stage of its growth, as it is always advantageous for young hardwood trees to have well-balanced and rather branchy tops in order to produce an abundance of leaves for carrying on the functions of the plant. By attention to the frequent pruning of hardwood trees in this way while young, and by attention to regularly and systematically thinning the nurses from them after they have reached beyond the height of 12 or 15 feet, no further pruning would be found necessary, as by that time the trees will be brought into the desired shape they were meant ultimately to attain, and judicious management in disposing of their nurses would keep them so ever after. We shall now give a few paragraphs in explanation of how the work of pruning is practically gone about.

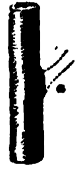
1789. In the pruning of all young trees, any branch of which may be got at by a man standing upon the ground, which branches, generally speaking, will not be more than one inch in diameter, the work ought to be done by the common forest pruning-knife. (See fig. 149.) This is not made with a hinge between the blade and the handle, as is the case in common pocket-knives, but the blade is fixed into the handle. The blade is also made straight in the face—that is, without any hook at the point, as is the case with garden-knives. The forester, in working with this knife, when he has no occasion to use it, puts it into a sheath of leather hanging by his side. In cutting off any branch of a tree from its stem with the forest pruning-knife, the operator takes hold of the branch with his left hand a little forward from its base, and eases it upwards, and at the same moment he applies the pruning-knife with his right hand to the base of the branch to be cut off, cutting it upwards in the same line as the stem of the tree—

Fig. 149.



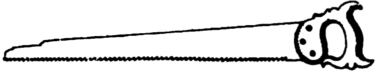
taking care not to enter the knife upon the plane of the stem of the tree, but a little upon the base of the branch to be cut off, say about a quarter of an inch upon the rise of the wood forming the base of the branch. By this means the stem of the tree is not injured, and at the same time the damp is thrown off the wounded part. In all cutting off whole branches immediately from the stem of a tree, the wounded part should be made perfectly smooth, paring it neatly all round with the knife, which should be kept very sharp. When the work of lopping off a branch is finished, the part will have the appearance as represented in fig. 150 at *a*; and in the course of two years after being done, the wounded part will be entirely covered over with young wood,—that is to say, if the subject is in full health.

Fig. 150.



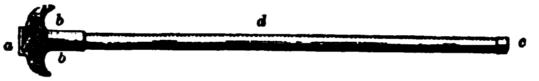
1790. When pruning operations are done upon a tree, the branches of which are within the reach of a man standing upon the ground, but which are too large for being easily cut off by the pruning-knife, the pruning-saw must be applied. (See fig. 151.) In all cases of cutting off a branch with the saw, care must be taken, first, to make a slight cut with it upon the under part of the base of the branch to be taken off, say nearly an inch deep if the branch be three inches in diameter, and so on with any other size of a branch in proportion. This is in order to prevent the branch, when nearly cut through, from falling away suddenly and tearing away the bark below its base upon the stem, which circumstance sometimes happens with careless hands. Care should be also taken to pare and make smooth with a sharp knife all the wounded surface made by the saw, which is always rough. By attending to this, the damp will not be so apt to lodge upon the wound.

Fig. 151.



1791. Where the operator cannot reach to the branch to be taken off, and where, of course he could neither use the pruning-knife nor the saw, the *pruning-chisel* is used. (See fig. 152.) In this instrument, the handle *d* may be of any convenient length to suit the height of the tree to be pruned; and it should always be made of a piece of good tough well-seasoned ash-wood. In using the instrument, the operator takes hold of the handle with his left hand, and puts the sharp face of the instrument *a* to the under part of the base of the branch. He then, with a mallet in his right hand, with one or more strokes upon the lower end of the handle *c*, which has an iron *ferrule* or ring upon it, forces the instrument through the

Fig. 152.



branch, and separates it from the stem of the tree. In the act of doing this, care should be taken to repeat the strokes lightly when the branch is nearly through; because, were a heavy stroke of the mallet given at this time, the instrument might be forced upwards and injure the stem of the tree, making a deep cut. When it is necessary to take any part of a branch off which may be considered too long and not in balance with the tree, the hooked parts of this instrument, *b b*, are used. They are kept very sharp on the inside; and in taking off any part of a branch with them, the operator pulls the instrument suddenly towards him, by which means a pretty large branch may be cut very quickly through. In using the pruning-chisel, a considerable deal of practical skill is required; and in the hands of a practised man, it is a most effective instrument for the purpose.

1792. All pruning operations should be done in the spring or summer months, observing to leave all maples till the summer season. We would not advise to prune any after the 1st of August, for after that time the motion of the sap becomes slower, and the wounds are consequently longer in healing up. We have observed that those trees which are pruned in May and June heal up in their wounds much faster than those done in July or a week in August. Our impression, therefore, is, that the month of June is to be preferred to any other month in the year for this operation. In pruning oak-trees in the month of June, the bark can be taken from such branches as are of any size; and we have found this to be a source of profit in forest management.

SECTION II.—PRUNING AS APPLICABLE TO CONIFEROUS TREES.

1793. The pine, the larch, the fir, and the cedar, but especially the trees of the three former families, from their natural strong tendency to shoot upwards in the form of one leading stem, with comparatively small lateral branches, are seldom found to require any such pruning as is generally deemed necessary for trees of the hardwooded species. But even in such specimens of the coniferous trees as do happen to grow strongly to side branches, and which, on that account, require to be checked in order to give the trees a more upright habit, a different mode of pruning must be resorted to from that generally applied to the hardwooded sorts. We have found that the amputation of healthy limbs from trees of the pine, the larch, the fir, and cedar, at least to any considerable extent, is highly injurious to the health of the subjects, from the wounds bleeding for years after they have been made, and thus causing a great loss of the sap. A live branch removed from the stem of a young oak or elm, in the season of its growth, bleeds very little indeed, and the wound heals up shortly after; but if one be removed from the stem of a pine or a fir at any season of the year, the wounded part will continue to bleed for a very long time. In pruning coniferous trees, therefore, the removal of live branches from their stems should be avoided.

1794. Trees of the pine and fir tribes, from their natural tendency to congregate together in masses, and from their being generally planted closely in our artificial plantations, are seldom found to require the pruning-knife to shorten or remove their branches: from these being checked in growth by their standing close to one another, the necessity for this is obviated.

1795. Although, however, the natural tendency of the coniferous tribes is to grow in masses, and although, when we plant them under such conditions as nature would seem to direct, we seldom or never find it necessary to check their branches by pruning,—still, when they are grown far apart from one another, as is the case in the greater part of the *pinetums* of this country, where the different species are grown for ornamental effect, they naturally send out such strong side branches as sometimes to deprive the leader, or main stem, of the amount of sap it requires to enable it to shoot proportionally upwards; and to render it necessary that we should apply some mode of pruning to check this overgrowth of the branches.

1796. From the fact that the removal of live branches from the stems of coniferous trees is highly injurious to their health, we should upon no account remove such, but adopt some other mode of pruning, and such a mode as will not necessitate the amputation of limbs, but merely act as a check upon the individual branches that seem to strive for the mastery with the leader or main stem. This is most completely done by merely stopping the points of the too luxuriant branches.

1797. Where, then, it is found desirable to grow specimens of coniferous trees singly, and so far apart from one another, or from other trees, as that the overgrowth of their side branches cannot naturally be checked by others standing near them, the points of the branches that seem to grow too luxuriantly should be *pinched off* with the forefinger and thumb, only to the extent of an inch or two, at the commencement of the growing season. This attended to while the trees are young, and before they become of a confirmed branchy habit, will have the desired effect of checking the flow of growth to such large branches, and of throwing a proportionately greater amount of the sap to the centre of the system for the benefit of their stems. This is all that is necessary in order to gain the end in view—namely, to give the leading stem the ascendancy of growth over the branches; and if this simple treatment of the branches is regularly attended to for a few years, the specimens so dealt with may be made to assume quite their natural characters.

1798. As a rule, the more healthy and vigorous in growth any tree is, the more its growth is naturally directed to the stem, the more clothed it is with proportionate branches, and therefore the less necessity there is for pruning. This rule we are confident in stating to be generally applicable to all trees, both *resinous* and *non-resinous.* We maintain, therefore, that where pruning is found necessary to put trees into a proper and natural shape, it is an evidence that the subjects have not been dealt with according to the natural laws that regulate vegetation, and that their management has been faulty. This of course may arise from various causes, but chiefly from unsuitable soil, from wetness in the subsoil, and therefore the want of proper drainage; and from planting on situations not adapted to the nature of the trees.

1799. Where it is found necessary to stop the points of the strong branches of any specimens of the newer sorts of pines, firs, and cedars, we do so generally by pinching off the points with the forefinger and thumb; but where we cannot reach the point of a branch needing the operation, we use an implement called the pruning-shears (see fig. 153), which we find to answer the purpose completely—as, from the one blade of the instrument being concave and the other convex, the shears clasp the twig firmly at once, and by a very slight effort one is enabled to cut it through, although it may be somewhat strong. The handles of this tool may be made of any convenient length to suit the object in view of the operator. When, however, the point of a branch needing to be pinched off is too far up on the tree to enable the operator to reach it even with the shears referred to, we use another description of pruner called the *averuncator*. This is represented by the figure 154, which is simply shears worked on the end of a pole by means of a lever handle to which a cord is attached for the purpose of the operator pulling the handle in the act of cutting through the twig. The pole of the averuncator may

Fig. 153.

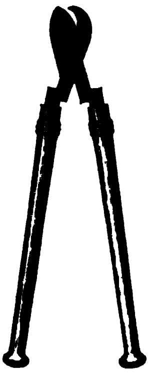
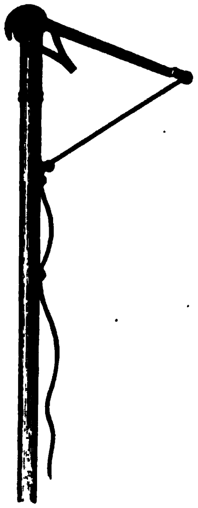


Fig. 154.



be made of any convenient length to suit the work to be performed, so that by means of these two implements the points of branches may be pinched off to a height of 25 or even 30 feet. Both of these tools are made by Messrs Saynor, Cooke, & Ridal, Sheffield.

1800. We seldom find the Scots pine, the larch, or any other of the perfectly hardy species of coniferous trees, require any assistance in this respect; but we frequently find it necessary to assist the different species of cedar, and the newer pines and firs—more especially where we have them planted on somewhat exposed parts, and where, consequently, they are of comparatively slow growth. Any treatment of the sort is, however, only necessary in the earlier stages of the trees. If they are attended to while young, and until the leaders have gained the ascendancy, no further attention is wanted.

1801. Another point which falls to be considered here in reference to the pruning of coniferous trees is, that of clearing them of *dead branches.* In examining our pine and fir plantations in this country, it is evident that we err in not clearing the trees, as they grow up, of all dead branches—as they die and become useless to the economy of the trees. The leaving of these to rot upon trees is injurious to the health of all classes of them, as well as deteriorative to the quality of their timber, inasmuch as each layer of young wood, as it is annually laid on the stems, encloses in it a portion of the bases of the dead branches, which never can adhere with the healthy wood, but remains to rot and to injure the quality of the timber. We recommend, therefore, that as the lower branches of the coniferous trees gradually die out—and in plantations they always do—they should be as gradually removed. Were this attended to, our woods would not only present a more pleasant effect, and be more healthy, but, what is of perhaps greater importance, would be more valuable in their timber at all stages. Many proprietors we know have done this for years past in all their plantations, both hard-wooded and others, and the advantages derived from it are evident on the crops, compared with the state of other plantations of similar ages, but which have not been attended to in this respect.

CHAPTER XIV.

SECTION I.—THE NATURE AND NECESSITY OF THINNING PLANTATIONS.

1802. Thinning is one of the most indispensable operations in arboriculture. The right understanding of its nature and design forms one of the most important points to be aimed at by every practical forester.

1803. The object which ought to be aimed at by the forester in the act of thinning, is the regulating of the trees in a plantation to such a distance one from another, and that in such a manner as is, from well-observed facts, known to be favourable to the health of each tree individually, as well as to the general welfare of the whole as a plantation.

1804. In order to grow any plant to that size which the species to which it belongs is known to attain under favourable circumstances, it is necessary that it have space of ground and air for the spread of its roots and branches, proportionate to its size at any given stage of its growth. Upon this the whole nature and intention of thinning plantations rests.

1805. There is a decided loss of timber, as well as shelter, whenever plantations are made too thin; and there is also equally a loss where they are not sufficiently thinned. Wherever plantations have remained long in a close state, and are thinned suddenly and severely, which we term injudicious thinning, they are at once cooled. This we reckon equal to being removed a few degrees of latitude farther north, or to a situation a few hundred feet higher than the original; and the natural consequence is, that the greater part of the trees which have undergone such treatment, become more or less what is generally termed *bark-bound;* the bark contracts and prevents the free flow of the sap,—consequently it stagnates, and in this state induces disease in the subjects. However, if the situation be a rather sheltered one, and the soil dry, a recovery of an overthinned plantation will generally take place; although the trees, after having been checked, will never attain that size they would have done had they been otherwise treated; but where the situation is exposed, and the natural soil cold and damp, a thorough recovery is hardly possible.

1806. On the other hand, where plantations are not sufficiently thinned, the trees become drawn up, weakly, and seldom attain the size of useful timber before maturity comes upon them. Where any plantation has stood long without being thinned, particularly one composed of coniferous trees, it is, we may say, impossible to recover it; for if even a very few trees be thinned out, a number of others, from the want of their shelter, are sure to die, which ultimately causes blanks to occur here and there; and the wind getting play in such blanks, great havoc is often made among the trees during a storm, the roots of the subjects being too few and weak to be able to keep them up.

From what has been here stated, it will appear evident that there is a great loss sustained by every proprietor who allows his plantations to be mismanaged, either from not thinning, or from over-thinning; and the result may be reckoned the same in both cases.

1807. Upon several estates which we have visited, we have regretted to see plantations of considerable age and extent with the firs overtopping and crushing down the hardwood trees. From the appearance of such plantations, it was evident that they never had been thinned, at least to any important extent. The hardwood trees were miserable-looking things, of their respective ages, striving for existence; while the firs and pines, which of course grew more rapidly, were generally tall in proportion, and of a broad spreading habit, from having been widely planted among the hardwood. The land was well adapted to grow the hardwoods to valuable size, but the plantations had been allowed to grow up, under the false impression that the firs were of more value than the hardwood for the sake of shelter.

Now, if the hardwood trees had been relieved in due time, they would have been valuable, both as timber and as affording shelter; while, had the conifers been all taken out for estate purposes, they would have been of value to the proprietor, and at the same time left a more valuable crop of hardwood on the ground. But, as the cases were, the hardwood plants were useless and past recovery; and upon the ground where a valuable crop of hardwood might have been, there existed only a few firs and pines of little permanent value, either for shelter or as timber.

1808. The distance at which trees in a plantation ought to stand one from another must, in all cases, be determined by the nature of the soil and situation upon which the trees grow, and also by the condition of the crop and the ultimate object the proprietor may have in view as regards any particular plantation. As a sort of guiding rule for thinning, we may here state, that if in any particular plantation it should be intended to rear up trees for park or lawn scenery, then, in such a case, the distance between each individual tree may be about equal to the height of the same; and this at all stages of growth after the first thinning has taken place, in order that they may have free room and air to form spreading tops as well as massive trunks, which is the true and natural form of every tree, and which constitutes the great beauty of lawn trees.

1809. If it should be intended to rear up a plantation of hardwood trees principally for the sake of value of timber, and for giving shelter at the same time, in such a case the object should be to keep the branches of each individual tree from interfering with those of its surrounding neighbours, and no more; and this at all stages of the growth of the trees after the first thinning, in order that they may not have so much free air and room as to allow of the spread of their branches horizontally, while they are not so much confined as to be drawn up weakly from the want of air. If it is intended to rear up a plantation of firs or pines for the sake of shelter and timber, the distance between each tree may be about the third of the height, which is the distance found most favourable to the useful development of the fir and pine tribes as timber trees.

1810. In making these statements as to the distances at which the different classes of trees may stand one from another, we by no means lay them down as absolute rules for guidance in thinning; being well aware that no definite rule can be specified for practice on this branch of forestry, as much depends on the state of the trees and the nature of the soil and situation. What we have stated in respect to each case will, however, in practice, be found as near the truth as any other sort of rule that could be laid down for guidance on the subject of thinning.

1811. In order to give a clear and practical description of the manner of proceeding with thinning operations in the forest, it will be necessary to treat of them under distinct heads; and this we shall do in the proper place. It may, however, be useful here to observe, that all plantations, ere they require to be thinned, must have grown for at least eight years; and even this period may in most instances be found too early. In fact, no particular period can be specified as to the length of time that a plantation should stand previous to commencing to thin it; for much depends on the nature of the soil and situation—on whether or not a plantation may have been well laid out—and on the state of the ground, as being dry or damp, and consequently the healthy or unhealthy state of the crop. These things considered, it will appear evident that no particular time can be stated as to when a plantation should be thinned for the first time, but that this must be judged entirely from the state of the trees, whether they may have grown rapidly or not. We have frequently found it necessary to thin a young plantation of seven years' standing, at which age the trees were 12 feet high; while, on the other hand, we have much oftener seen plantations of twelve years' standing, scarcely the length of requiring to be thinned: therefore, observation upon the spot is the only sure way of determining this point.

SECTION II.—HOW TO PROCEED SYSTEMATICALLY IN REGARD TO THE THINNING OF PLANTATIONS ON ALL WOODLANDS.

1812. After properly preparing the soil, and adapting a crop of young trees to it, *systematic thinning* has the next greatest influence in bringing the crop to a satisfactory result, and we are glad to be able to record here, that within the last ten years a very great improvement has taken place in the forest management of Great Britain in respect to systematically thinning the crops, showing that foresters in this country are now convinced of the great advantages derivable from this course of operation, and that the most intelligent part of them have made up their minds to pursue it in future. We have lately travelled over a large part of England, and of Scotland and Ireland as well, taking observations preparative to writing this edition of our work, and found, on many parts where woodlands had been formerly much neglected, that systematic thinning is now being put in operation.

Although at the present day, however, there are many foresters who understand and can apply systematic thinning to the woods and plantations they have the management of, still there are, we believe, as many who are not possessed of this knowledge, or at least do not act upon it, and to this is to be attributed the still great extent of inferior crops we find in plantations in many parts of the country, upon all descriptions of land, and on large and small properties alike.

1813. We stated in the last paragraph that to the want of a proper understanding of systematic thinning in the case of many foresters of the present day, is to be attributed the want of its application to a large extent of our woods, and that this is in a great measure the cause of the inferior crops we find on a large proportion of our woodlands. This is not to be doubted, as wherever systematic thinning has been applied, the crops so dealt with are nearly of double the value, at a given age, as compared with others that have not been attended to in a similar way, circumstances of soil and climate taken into consideration.

1814. On all the properties, respecting the woods of which we have reported, we have invariably recommended as a means of improvement, that the several ages of plantations should be divided into equal portions, and that one such portion should be periodically and systematically thinned—once in three, four, five, or six years, according to the ages respectively. Wherever this system has been intelligently put into operation, it has been attended with the greatest possible advantages to the crops—not only making them more valuable from their being kept in superior health, but also to a large extent lessening the expense of labour, and therefore causing a greater amount of clear revenue to be derived from them than could be drawn under the former and unruly state of their management.

1815. The scheme of systematic thinning which we have referred to, which we adopt in the management of the woods of which we have the charge, and which we recommend to others, may be shortly described by reference to a statement in illustration. In order to this, and to make the scheme as clear and intelligible as possible to all classes of foresters, we shall take up a case of the woodlands on a supposed estate; say on one on which there are plantations of various ages, extending to 3225 acres in all. The statement, then, is as follows:—

1816. **STATEMENT** SHOWING THE EXTENT, AGE, AND CHARACTER OF CROPS OF THE PLANTATIONS ON THE ESTATE OF WOODLANDS, IN THE COUNTY OF ———, AS IN 1880.

Names of Plantations.	Description of Crops.	Age in Years.	1. Extent under 25 years.	2. Extent above 25 and under 35 years.	3. Extent above 35 and under 45 years.	4. Extent above 45 and under 60 years.
			A. R. P.	A. R. P.	A. R. P.	A. R. P.
Redbraes, . .	Oak with Larch as nurses,	10	304 2 ...			
Greenhills, . .	Larch and Pine,	32	... ...	236 1 20		
Stanford,. . .	Oak,	50	... ...	... ...	... ...	480 ... ...
Raeburn,. . .	Larch and Pine,	43	... ...	... ...	208 2 20	
John's Wood, .	Ash,	...	... ...	36 3 ...		
Lead Hills, . .	Larch and Pine,	20	409 3 ...			
The Grove, . .	Oak, Sycamore, and Elm,	58	... ...	... ...	... ...	79 1 ...
Tom's Meadow,.	Oak,	40	... ...	... ...	90	
Wallsend, . .	Oak, Ash, Elm, and Larch,	40	... ...	... ...	206 3 ...	
Nord Hill, . .	Oak with Larch,	17	305 3 ...			
Ann's Brae, . .	Larch and Pine,	30	... ...	97 1 ...		
Thuylaw, . .	Oak,	40	... ...	... ...	225	
Bar Muir, . .	Larch,	15	90			
Revach, . . .	Pine,	50	... ...	... ...	... ...	80 ... ...
Castle Hill, . .	Larch,	20	35			
Stainton, . . .	Oak,	32	... ...	40		
Yarrow More, .	Oak,	28	... ...	60		
Eildon More, .	Larch,	25	... ...	104		
James Wood, .	Pine,	30	... ...	36		
Dunedin, . . .	Oak and Larch,	20	100			
			1245	610 1 20	730 1 20	639 1 ...

1817. Having given this statement, we shall next suppose that it represents the names, the description of crops, and the ages of the several plantations on an estate, as well as the extent classified betwixt the different ages stated in the four columns, and as numbered 1, 2, 3, and 4. Here, then, we have represented four classes of plantations, according to their ages, as they require to be periodically dealt with in regard to thinning.

1818. Under the first column, it is brought out that there are 1245 acres of a class under twenty-five years of age. As the crops of the ages represented under this head are understood to be in a rapid state of growth, and the trees standing comparatively close to one another, more frequent thinnings are necessary, in order to keep them in a healthy and promising state, than are requisite with others at a more advanced stage. In dealing with this class, therefore, we divide the several plantations embraced in it into three as nearly as possible equal portions, and thin one such portion regularly and systematically each year successively. That is, suppose that the first portion was thinned in 1880, we would thin the second in 1881, and the third in 1882, so that in the year 1883 we would again thin the portion which was operated on in 1880; and so on with the other portions successively.

1819. Under column No 2 it is brought out that there are 610 acres 1 rood 20 poles, of ages between twenty-five and thirty-five years. This class, from its being understood to have been well thinned while of the age of the class No. 1, and from the trees constituting it not being so much disposed to grow to the spread of branches, as to the increase of timber in the stems, does not require to be so frequently thinned as class No. 1; and we therefore lay it down as a rule, that a judicious thinning once in each period of four years is enough for it. For this reason, then, we divide the plantations of this class into four as nearly as possible equal portions, and thin one such portion each year successively, as has been described in reference to class No 1.

1820. Again, under the third column, it is brought out that there are 730 acres 1 rood 20 poles, under a class of plantations of various ages betwixt thirty-five and forty-five years. The trees of this class being older than those of the other two, and understood to have been properly thinned and attended to up to their respective ages, will not require such frequent thinnings as either of them; and we have therefore laid it down as a rule for our own guidance, that plantations of the ages specified only require to be thinned once in the five years. Here again, accordingly, we divide them into five equal portions, and thin one such portion each year successively, and in the same systematic and periodical way as that stated in reference to the other classes.

1821. With regard to the class under column fourth, which is supposed to extend to 639 acres 1 rood, of the respective ages of the crops from forty-five to sixty years, it is understood that the trees should have attained their confirmed habits, and that they should grow comparatively little in the spread of their limbs, even less frequent thinnings will be necessary for them than for the younger classes. These may be thinned only once in the six years, and accordingly should be divided into six portions, one of these to be operated on each successive year as before.

1822. It will be found that trees above the age of sixty years require very little thinning indeed; that is to say, if they have been attended to properly while in a younger state, and for this reason we never class them for systematic thinning, as at such an age the trees of any plantation should be set out to nearly their permanent distances. We do not mean to say that the trees in a plantation upwards of sixty years' standing are to require no attention; we only mean that they, at such age, cannot be said to come under a class for improvement by thinning, but should be in a state generally independent of the operation.

1823. It is of course to be understood from what has been stated in reference to the different ages of plantations classified in the foregoing statement, that as they rise in age they will fall to be classified accordingly, and to be thinned at more distant periods. That is, for example, while the plantation called Nord Hill is under twenty-five years of age, it will be thinned once in every three years; when at and above that age, and till it is nearly thirty-five years old, it will fall to be thinned once in every four years; and so on.

1824. By adopting such a scheme in regard to the thinning of the plantations on any estate, every one of them receives equal attention and justice at all times, and none could get out of order, as is always the case, to the great loss of the crop, on all estates where no such system has been adopted. In our inspection of woods in all parts of the country, we saw that some such scheme for systematically thinning them was much wanted, and therefore we adopted the one just described. We have put it into operation for the last thirty years on the woodlands we have had the charge of, and have recommended it to others,—and we are happy to see that many parties have adopted it in England, Scotland, and Ireland; and wherever it has been properly carried out, the greatest advantage has resulted to crops subjected to it.

1825. It is an undeniable fact that the weakly, unprofitable, and therefore unsatisfactory state of a large extent of plantations, is to be attributed to the neglect of systematic thinning. Were this scheme properly adopted and attended to by all interested in the rearing of woods, we should soon have a very different class of them from what we have at the present day; in short, a large extent of woods has become premature, from not attending to this point. We frequently see woods growing upon the best land, matured when only some sixty years old: this arises from neglect of systematic thinning.

SECTION III.—THE THINNING SYSTEMATICALLY OF PLANTATIONS ON SMALL PROPERTIES.

1826. On comparatively small landed properties, say such as those on which the woodlands do not extend to much more than 800 acres, the application of the scheme of systematic thinning which has been described in the foregoing section may very properly be modified to suit them, and still have the same effect in the working. The scheme of dividing the plantations into classes according to age, is advantageously applied to woodlands of any extent; but that of again subdividing the classes, we have found most advantageously suited for the carrying out of systematic thinning where the woodlands to be operated on are extensive, say ranging from 1000 to 4000 acres.

1827. In applying this scheme of systematic thinning, therefore, to the woods on small properties, we recommend that they should be classed according to their ages, in the same way as has been described under the preceding paragraphs, but not that they should be subdivided—as any subdivision of such small extents as would in these cases fall to be dealt with, would be troublesome and tedious in carrying out the operation. We shall suppose a case in illustration of the mode we recommend in regard to the systematic thinning of plantations on small properties.

1828. Supposing that there are 800 acres of plantations on a property, and that this extent is classed according to age, thus:—300 acres under 25 years of age; 180 acres above 25 and under 35 years; 210 acres above 35 and under 45 years; and 110 acres above 45 and under 60 years. In order to thin these classes regularly and systematically, it is only necessary to thin the 300 acres all in one year, and at intervals of three years; to thin the 180 acres also all in one year, but at intervals of four years; to thin the 210 acres all in one year, but at intervals of five years; and the 110 acres all in one year, but at intervals of six years.

1829. If, however, the plantations on a small property were all of a class under 25 years, then they could be divided into three equal portions, and one such could be thinned each year successively; or if they were all of a class above 25 and under 35 years, they could be divided into four equal portions, and one thinned each year, and so on; the great object being that of securing such a division of the plantations as to insure the whole being regularly operated on at periods according to age.

SECTION IV.—THE THINNING SYSTEMATICALLY OF PLANTATIONS ON EXTENSIVE PROPERTIES.

1830. When the woodlands upon an estate are what may be called extensive, we have found it absolutely necessary to divide them into districts, and to place over each a competent forester, and to treat them as separate estates. This is the only way in which the thinning operations on extensive woodlands can be properly conducted and looked after; as we have found that when one man has to superintend the operations on more than from 4000 to 5000 acres, many of them are not sufficiently looked after, and consequently get partly out of order. An outline of our own mode of procedure in reference to the thinning of say 12,000 acres of woodlands on one estate, may be shortly stated in illustration of the point under notice. It is this. We have the whole of the extent divided into three distinct districts, of as nearly as possible 4000 acres each, over which we place a competent forester, whose duty it is to attend to thinning and other operations on it, as if it were a distinct estate. Thus divided, we have the plantations of each classed in the way detailed under paragraph 1816, and thinned as described under the following paragraphs. By such a mode of subdivision, any extent of woodlands may be as systematically and regularly attended to as those on a small property—and in fact, more so; as on a large scale the operations are generally more profitably conducted than on a small one, from the fact of a better class of men being generally engaged in them.

1831. In the classing of the different plantations for systematic thinning, it is, of course, understood that the forester should enter them all into a book kept for the purpose, in which should be stated the dates when each was thinned; so that at any time, by looking into such a book, he can tell when each plantation was last thinned, and when it falls to be operated on again, according to its age. This is our own mode of going to work. We have found it work well; and therefore we recommend it to others.

SECTION V.—REARING UP AND THINNING OF OAK PLANTATIONS.

1832. The oak being a valuable tree on account of both its timber and bark, is generally cultivated in Great Britain with more care and attention than any other of our forest-trees; therefore we consider it necessary and proper to treat of the manner of rearing it under a distinct head.

1833. Three different systems of rearing young oaks are practised among foresters of the present day, each of which is put into practice, in various parts of the world, according to the views of the planter in respect to the land he has to deal with in planting.

The three different systems are these: First, that of sowing the *acorns* or seed at once upon the ground where it is intended the trees are to grow up and become timber; Second, that of transplanting the trees from the nurseries in the usual way, and in one year after being planted, when their roots are established in the ground, cutting each tree over by the surface of the earth, and allowing the stock so cut to stand for one, or it may be two years, when a number of young shoots are produced immediately from the earth, strong enough to allow a choice to be made of one to stand for a permanent tree when all the others are destroyed; and, Third, the system of planting the young trees in pits, as is usually done, and allowing them to come away in their own natural way.

1834. With regard to the first—namely, the system of sowing the *acorns*, or seed of the oak, at once upon the ground where it is intended the trees are to grow up and become timber—we have to refer to our remarks on the subject of rearing trees by sowing the seeds on the land where they are to grow permanently, as given in the 6th section of Chapter XI. of this work.

1835. As to the second system of rearing the oak when young—viz., that of transplanting the young trees from the nursery into the forest ground; in one year after, when their roots are fairly established, cutting them over by the surface of the earth; and when a number of young shoots are produced from the stocks, choosing the strongest and healthiest for a permanent tree in each plant.

This system is very much practised by foresters who have to raise hardwood plantations in high-lying districts of the country, where it is well known that young hardwood plants are apt to suffer a severe check when newly-lifted from a sheltered nursery, owing to the cold cutting winds which prevail in such quarters. Indeed, in all cases, young hardwood trees, which may have been reared in some of the public nurseries near large towns, when they are removed to, and planted in, a high-lying part of the country, seldom do much good for three or four years after their removal. The whole part of the plant situated above the grass or herbage of the ground becomes stunted, and very often dies down to within 2 or 3 inches of the surface, which part remains fresh, because sheltered by the foggage from the winds; and, indeed, if the plants are left to themselves in such a situation, they, the second year after being planted, and after the roots have properly established themselves, send up a number of young shoots from the live part about the surface of the ground, which young shoots ultimately become trees of inferior magnitude; but if those young shoots be thinned out to one individual, a tree of the usual magnitude will be the result. Now, this system of cutting over is only assisting nature; and if, instead of allowing the young trees to lie dormant for two years, as is the case when left to nature, the forester cuts each tree over by the surface one year after they are planted, he places himself by his art two years in advance of nature as left to herself; for as soon as the trees are cut over, they each send up from three to six vigorous young shoots, which, when they are of sufficient age, can be removed, with the exception of one, which is left as a permanent standing tree. We have, by adopting this method, had strong vigorous young shoots of 2 feet high the second year after planting; while, where we have not had them cut over, three or four years elapsed before we had shoots of the same strength.

We are acquainted with foresters who have to deal with the rearing of hardwood in high-lying parts of the country, who, upon receiving their young hardwood plants from the nurseries, of whatever species they were, cut each down to within 3 inches of the roots, and plant them in this state in the pits which are prepared for them in the forest. Their reason for doing so is, that they assert they gain young shoots a year sooner than if they had allowed the plants to remain for one year in the ground previous to being cut over, as is the usual way. But upon examining the state of the young hardwood plants, which had been planted one year before we visited the place, and inspected this system of going to work, we found that all the young trees, which had been so cut previous to planting them, produced but very weak shoots the first season; and, as we apprehended, they in fact made no vigorous growths till the second year. In this case, therefore, something was lost instead of gained; for until the roots of the young plants are fairly established, very little young wood can be produced. The plants require the first year in order to establish their roots; and if they are forced to make wood during that year—as is the case when they are cut over at once—the wood seldom ripens well, but is weak, and apt to be nipped by the first frost of winter; but when the plants are allowed to have their own natural way for the first season after being planted, and when the stem is allowed to remain and push out a few leaves in order to elaborate any sap drawn up by the roots, these roots become during this period properly and firmly settled in the earth, and are rendered strong and vigorous for being called into action the year following. Hence it is that young trees, cut down the year after being planted, always make more vigorous and stronger shoots in that one season, than trees of the same character cut down when planted, and having two years' growth upon them.

In conclusion, this system is advantageous, and answers well, with oak, or indeed with any other hardwood plants, when planted out in a high district, and after being removed from a sheltered nursery; but in no other case is it necessary.

1836. The third system of rearing the oak when in its young state, as formerly mentioned, is that of planting the young trees in pits, as is usually done, and afterwards allowing each to come away in its own natural way.

This is the system practised in all moderately sheltered districts for the planting of oaks, as well as all other sorts of young trees, and need not be enlarged upon here. We may mention, however, that in all moderately sheltered districts, young hardwood trees of any sort receive very little check from being transplanted, if they are not above 4 feet high, and have been twice transplanted in the nursery, so as to give them well fibred roots,—and if the soil is one adapted for the growth of the trees planted, and the work carefully and properly done; but if the soil is not of first-rate quality, and if the situation is one much exposed, the trees always receive a violent check, and, consequently, the bark upon the young trees becomes constricted, and will not carry on its natural functions; but the roots being as healthy as formerly—if the soil is at all suitable—they, when the old tops are gone, send up young shoots to supply the place of the former, which, as they grow up, become habituated to the climate and situation, and consequently form trees adapted to it. Therefore the planter, when he meditates to bring up a plantation of young oaks or other hardwood, must judge for himself as to which of the two last-mentioned systems he should adopt; and that of course must be regulated by his grounds being exposed or sheltered.

1837. Different opinions continue to prevail among planters as to the distance at which oak-trees should be planted at the offset, where it is intended to rear up an oak forest. There is no doubt that a difference of opinion will still continue to prevail, according to the views of the proprietor and his forester conjointly; but this does not form a definite answer to the question which has often been put to ourselves by proprietors—namely, At what distance ought oak-trees to be planted with the view of realising the greatest possible profit from the land in the shortest possible time after planting?

This question cannot be answered to all proprietors alike; for in one neighbourhood young oak-trees are of considerable value, and in another of comparatively little; in one neighbourhood young larch firs are of more value than young oaks as thinnings, while in others the reverse holds good.

1838. In the rearing of oak plantations in exposed parts of the country, where these do not grow rapidly, it is absolutely necessary, for the protection of the young oaks, to have a considerable quantity of larch or pine among them, and that, too, till they are considerably advanced; while in more sheltered districts, where there is little doubt of the oaks growing rapidly, fewer nurses are required. In the laying down of oak plantations, we are in the habit of taking all the above points into consideration; and from having had experience as to the growing of oaks in almost all possible situations, we find that, in order to grow the oak to advantage, it is necessary that every forester should do the same, and by no means go to work according to one set of distances. It is in this way that these differences of opinion relative to distance have arisen; for every experienced forester finds that one system of going to work will not answer all parts, and, judging for himself, he acts accordingly; while, on the other hand, the man without experience advises to plant in all cases according to one set of distances, and the natural consequence is that a failure is as likely to be the result as a crop. Having premised the above, the determination of the question relative to distance will now be more easily understood, and we shall answer it according to our own method of practice in different situations.

1839. When a proprietor meditates planting a part of his grounds in the form of an oak forest, without mixture of any other sort of hardwood, let him first ascertain if young oaks, when cut down in the process of thinning, will sell to advantage in his neighbourhood, and if they will pay him better than any other sort of wood of the same age. We shall suppose that young oaks, of the size generally termed spokewood — that is, trees from 5 to 8 inches diameter, suitable for making the spokes of wheels—sell well; therefore, in such a case we would advise him to plant the young oak-trees at 8 feet apart, and make up the ground with larch to 4 feet between them. By the time that the larch are all taken out and the oaks properly brought into shape, they will be very valuable for many purposes, independent of the bark.

1840. Again, if on full consideration it is found that oak in the young state above referred to—that is, from 20 to 25 years of age—will not sell well in the neighbourhood, while larch as thinnings will be much more valuable, then plant fewer oaks per acre—say, at 12 feet apart, and make up with larch to the proper distance. In this way, by the time the larches, &c., are all taken out, the oaks will be of a pretty large size, and fit for many valuable purposes before the cutting of any of them is found necessary.

1841. Again, where it is found practicable to have an oak forest in an exposed part of the country, it will be necessary to plant a good many larch or pine among them for the sake of producing shelter through the whole plantation, until the oaks have arrived at a good size; and in a case of this nature, from 10 to 12 feet is quite enough for the distance between the hardwood plants, making up with nurses in the former instance to 3½ feet over all; and in the latter—that is, 12 feet apart—to 4 feet over all. In the same plantation we very frequently plant at both of the distances above mentioned—that is, in exposed parts of an enclosure we plant the oaks at 10 feet, and make up between to 3½ feet over all; and in more sheltered parts of the same plantation we plant the oaks at 12 feet, and make up with larch to 4 feet; and when the situation is decidedly a sheltered and low-lying one, we plant the oaks at 15 feet apart, and make up with nurses to 5 feet over all. In many cases, where young larch are very valuable for mining purposes, we have planted the oak at 20 feet apart, and made up with larch among them to 5 feet over all; in which cases no oaks require to be removed till they are of large size, and after all the larch are removed in the first place as thinnings.

The above, which is our own system of going to work as regards distance, will, we think, form an answer to the question formerly stated; and it now remains for us to enter a little into the practice of rearing up such a plantation as we have pointed out above.

1842. Suppose that a tract of ground has been planted with oak at 12 feet apart, and the intermediate spaces made up with nurses to such a closeness as to leave the whole plants over the ground at 4 feet distance, and supposing that the pruning of the oak plants has been regularly and judiciously attended to as recommended in the *first section* of CHAPTER THIRTEEN in this work, up to the time the plantation is about 8 or 10 years old, little or no pruning will ever be afterwards required, and at this stage the crop should be carefully looked over with a view to thinning where necessary.

1843. The oak not being a rapid-growing tree at any stage of its growth, as compared with many other sorts of hardwoods, the young plants will not, at 8 or 10 years' standing in a plantation, have attained a large size, probably not much above 10 feet high on the average; but if the nurses which were planted among them for the purpose of giving shelter have thriven well, the oaks will be deriving benefit from their shelter, and progressing rapidly. In fact, young oaks never do come away well until the nurses rise up around and afford them shelter, more especially if the situation in which they are planted be at all an exposed one.

1844. An oak plantation having arrived at the age of 8 or 10 years, and the young trees having been attended to up to this stage in the way of pruning, the next step in the rearing of such a plantation is to thin away any of the nurses as soon as they seem to encroach upon the oak plants. This thinning, in the rearing up of oak plantations, must at all times be more severe than when thinning away nurses from among the common kinds of hardwood. And, indeed, this particular forms the only difference worth mentioning between the cultivation of the oak and the cultivation of hardwood in general; that is, the oak-trees, after they are once properly established in the ground, and brought into proper shape by judicious pruning, must, through the whole course of their culture afterwards, have more room and air than any other species of hardwood trees. The reason of this difference as regards the cultivation of the oak is this:—The oak is a valuable tree, both on account of its wood and bark: the wood is more valuable when grown of proportionable diameter than when of great length, and it is also of more durable quality when freely exposed to the air than when drawn up weakly and to a great height: thence arises the necessity of giving the trees free circulation of air in order to have valuable wood. The oak is also valuable on account of its bark, as we have already mentioned. Now, in order to produce bark, a tree must have extent of wood, whether that be in the form of trunk or branches. When oak-trees have free room for expanding themselves, the lower branches form into bends for shipbuilding, which is a valuable object. The trees also, being more branchy in themselves, possess a greater surface for the production of bark; and the bark itself, having free air, becomes thick and heavy upon the tree. It is perhaps not generally known that oak bark produced upon trees having free air about them weighs almost double that of an equal surface taken from a tree confined and not having air; and, at the same time, bark of such weight is always more valuable, because containing a greater proportion of tanning matter.

1845. What we have here said relative to the cultivation of the oak we regard as sufficient to convince any proprietor of the necessity of keeping his oak forest thinner of trees than any other of his woods. We need only add, in conclusion, that in every other respect oak plantations are to be managed upon the same principles as other hardwood ones. Oak-trees are never reckoned of full age till they have attained one hundred years; therefore, after a plantation of oaks has received its final thinning, it should be allowed to stand until that age before cutting down.

SECTION VI.—SYSTEM OF THINNING AND REARING UP OF MIXED HARDWOOD PLANTATIONS.

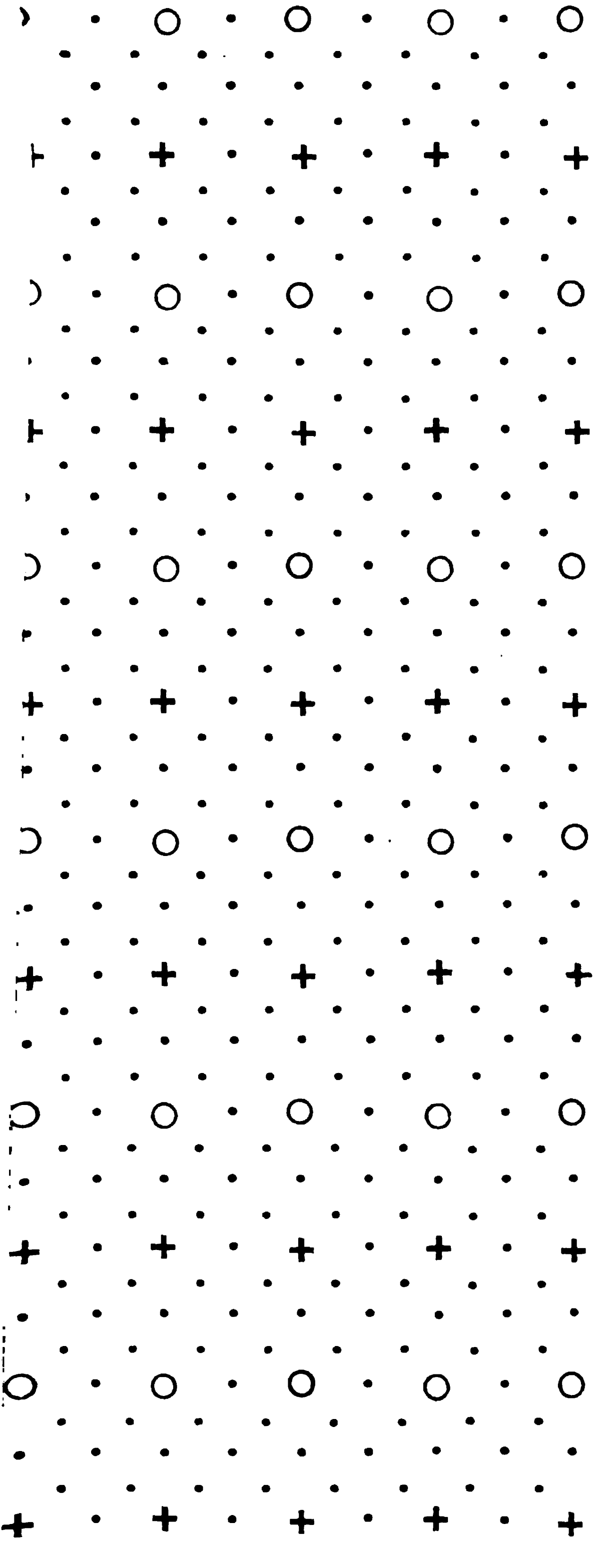
1846. The rearing up of hardwood plantations to anything approaching natural perfection requires much more attention and practical knowledge from the manager than pine, larch, or fir woods do.

In a pine, fir, or larch plantation, the trees are alike of an upright habit of growth, from which circumstance they are very easily regulated and kept in proper place and order; but in a plantation consisting of many different kinds of hardwood, all growing in a mixed state — some, as the elm, inclining to grow much to horizontal branches, and others, as the ash, tending to an upright growth — much attention is necessary for the first thirty years in order to keep the rambling sorts within due bounds, and from overtopping and injuring their neighbours, which may be less robust in their young state. And as it is in the young state that hardwood plantations may be made to do well or otherwise, according as they may be attended to, it is a matter of the first importance in good forestry that the manager be well acquainted with the circumstances which retard the progress of young trees, as well as those which are known to be favourable to their healthy development. Being well aware, from past experience, of the extensive damage which is done to young hardwood plantations in consequence of their being neglected in their young state, we shall here lay down at some length the method which ought to be pursued in order to have healthy and valuable hardwood trees—dwelling more particularly upon the system which ought to be adopted in rearing till the trees attain thirty years of age; after which time, if they have been properly attended to, little care is required as regards trees individually, except to give them room as they advance in size.

1847. Let the accompanying diagram represent a piece of ground which has been planted with different sorts of young hardwood trees, at 12 feet apart, the ground being made up between them with larch and pine, to act as nurses, so that the young trees stand over all at about 4 feet from each other.

In the diagram the different sorts of trees are represented by marks differing either in colour or in character, thus:—

OOD PLANTATION. AT PAGE 584.



Oak trees, planted at 24 feet apart, are represented by a red circle.
Ash trees, planted at 24 feet, by a black circle.
Elm trees, planted at 24 feet by a red cross.
Sycamore trees, planted at 24 feet, by a black cross.
Larch nurses, planted at a little over 4 feet from hardwood, by a red point.
Scots pine nurses, planted at 6 feet from hardwood, by a black point.

1848. Upon examining the diagram, it will be found that each sort of hardwood tree is planted in such a manner that each tree of the same sort is exactly 24 feet from the next of its own species. This is an important point to attend to in the planting of mixed hardwood plantations, for it may ultimately be found necessary to cut out the whole of one sort; and in this case, the others which were left would stand at equal distances after these had been removed. The ash and sycamore are planted within 12 feet of the oaks, while the elm is kept nearly 17 feet off them. This is another point of much importance to attend to in the planting of mixed hardwood plantations. For example, supposing that the oaks, which are planted at 24 feet apart, are intended to remain as the only ultimate crop, then the ash and sycamore, which are of an upright habit of growth in a close wood, could grow for a longer time close upon the oaks than the elm could safely do, which is of a spreading habit; therefore the elm, at nearly 17 feet distance from the oak, would be as close upon the oak at 30 years' standing as the ash and sycamore at the same time. The larches are planted a little over 4 feet from the hardwood plants. The reason of this is, that the larch, from its light and airy habit of growth, is found not to hurt the hardwood plants so much as the Scots pines would do at the same age; for which reason, also, the Scots pines are for the most part planted 6 feet from the hardwood plants. Besides, the larches, being planted next the hardwood, are likely to be taken out first in the way of thinnings; and in this case they are of far greater value when cut at an early stage than the Scots pines. The four larches, which are planted next each hardwood plant, can be all taken away, in the way of thinning, a considerable time before it is found necessary to cut a Scots pine; and by this arrangement the Scots pines can be allowed to stand and grow till they become of some value.

1849. We shall now suppose that a pretty large tract of ground has been planted with young forest-trees exactly in the manner represented in the diagram. We shall further suppose that the ground so planted has been properly drained and rendered congenial for the future welfare of the plants; for let us again observe that much of their future success depends upon this. A very indifferent soil, if well dried, and rendered porous by drainage, will produce much better timber than a naturally good soil having a superfluity of water in it, and which has not been improved by drainage; hence the importance of a thorough clearing of the ground from all superfluous water, and of opening it up in the subsoil, before planting forest-trees upon it. Presuming that the ground has been well dried and made porous, by means of open drains put on at consistent distances, and that the young trees have been properly planted and attended to in the way of pruning, according to directions as formerly given in this book, the next question which naturally occurs is, At what stage of the growth of such a young plantation should thinning commence? This is a question which has given rise to a great deal of useless discussion among those who have the management of plantations—all this arising from not taking into account the effect of altitude upon the growth of young trees; and not only the effect of altitude, but even the effect of soil and aspect, and, in fact, many other local circumstances which cannot always be accounted for. For example, in districts of the country pretty far inland, and upon estates of a generally level nature, 400 feet above the level of the sea, we have seen foresters thinning their young plantations for the first time at eight years old from the time of planting; while, on the other hand, upon the west coast of Britain, upon estates within a few miles of the sea, and at 400 feet above its level, we have seen young plantations, under excellent management, not ready for thinning when they were ten years old, and that although the young trees were planted at the same distances from one another in both cases. Now, this at once points out that, independent of altitude, other local circumstances must be taken into consideration,—as, for instance, if the ground planted be upon a level part of the country, the trees will grow quicker than they could do in a hilly district, even supposing the altitudes of both to be the same; while, again, trees grow much faster in a glen or hollow than upon a common level piece of ground, and in a large plantation than in a small one. And with regard to soil, when it is of a light or sandy nature, young trees grow very quickly upon it for a few years, and soon arrive at maturity; while, at the same altitude, upon a heavy or clay soil, trees will be longer in getting away, but will ultimately be far superior to those planted upon the light soil. Every intelligent forester, who has had the management of plantations upon an estate of considerable extent and of a varied surface, will have had occasion to remark the great difference that occurs in the growth of plantations, even within the bounds of one estate; and that according as the plantation may be situated upon a sudden rising height, upon flat level ground, in a hollow or glen, upon sandy or light soil, or upon heavy clay soil; and we must say also, according to shelter received from surrounding plantations, &c. It will then at once appear evident that, to give anything like a rule for the time at which a young plantation should be first thinned, is a thing, properly speaking, impossible, as we have learned from practical experience.

1850. We shall now suppose that we have in hand a plantation of 50 acres in extent, which has been planted with a mixture of hardwood, pine, and larch, exactly in the proportions pointed out in the diagram. This plantation we shall suppose to be upon a moderately exposed situation, say 800 feet above the level of the sea, and pretty far inland, having a soil of moderate capabilities. Such a plantation will, in all probability, be ready for the first course of thinning when ten years old; but before commencing to thin out any of the larches, it will be necessary, in the first place, to have an eye to the state of the hardwood plants, which of course are intended as the principal and ultimate crop upon the ground.

1851. In the rearing of plantations generally, and more especially in the case of those in which it is intended to rear up a supply of various kinds of hardwood for general usefulness, independent of a particular sort which is to remain as an ultimate crop upon the ground, the forester requires to watch them continually, in order to keep them in a constantly healthy growing state. The trees, after they have got properly established in the ground, must not be allowed to become so crowded together as to impede the free action of air among them; neither must they at any time be thinned so severely as materially to cool down the usual temperature of the whole as a plantation, as is too often done. A forester, therefore, in order to raise plantations profitably, should have the state of every plantation under his charge continually in his eye; for unless this be the case, matters will without doubt go wrong. The forester will then, in the case of such a young plantation as we are now discussing, observe at what time the points of the side branches of the larches begin to touch those of the hardwood plants next them; and as soon as this ensues in the plantation generally, it is time to thin out such of the larch as interfere with the branches of the hardwoods.

1852. We said above, that as soon as the points of the side branches of the larch begin to touch those of the hardwood next them, it is time to commence thinning. This is a stage in the culture of young hardwood trees to be closely observed by the intelligent forester; for if the branches of the nurses are allowed to encroach upon the hardwood, they will very soon hurt them by lashing and crushing them down: for let it be kept in mind, that the larch grows much more rapidly than the hardwood does; and the former are not planted with the view of doing injury to the hardwood plants, but, on the contrary, to nurse them up and protect them. Again, on the other hand, there is a possibility of injuring the hardwood plants by taking the nurses too early away from them; and this also ought to be avoided as much as keeping them too close. Every forester of extensive experience will have observed that hardwood trees, when at the stage to which we are now adverting, if kept too far from their nurses, are extremely apt to become of a branchy coarse habit, and not inclined to grow upwards so much as to grow to strong side branches. This is an evil of very great magnitude, and ought in all cases to be guarded against where clean healthy timber is the object. There is, therefore, a medium course to be followed; and the question is, By what feature can an inexperienced person decide upon the proper time that he should begin to thin away nurses from the young hardwood? The right answer is not so easily given as many would suppose. To the eye of an experienced forester the matter is indeed simple, but to convey his experience upon this point to the mind of an inexperienced stranger, is not such a simple matter.

The best rule for guidance in this matter is, to go carefully through among the trees, and mark particularly the state of the hardwood plants, specially observing if the branches of the larches are here and there lying upon and interfering with those of the hardwood; and if this be the case, thinning should be commenced. Having, then, decided that thinning is necessary, the first step in the work is to have the nurses marked which it is considered should be taken out; and in order to do this properly, considerable practical judgment is required. All theoretical men, who have had little practical experience to form their judgment with regard to thinning young plantations, maintain that, at a certain age of a plantation, a certain number of trees ought to be cut away from each hardwood plant, thus reducing practical forestry to a few rules of practical geometry. This sounds all very well in the ears of other inexperienced men, but when reduced into practice, it proves an utter absurdity. Plants are, like animals, often found to die suddenly, and that, too, without our being able to give a reason for it; besides, nothing is more true than that all trees of the wood do not grow alike; and seeing this we must, in the case of thinning, judge for ourselves, and, from practical observation, choose which should stand and which come out.

1853. In practical forestry the operator will very generally find that of the four larches planted about each hardwood tree (see Diagram), one or two may be of a pretty large size, and others of a smaller; one or two may be lying too much upon the hardwood plant next them, and others be found not doing it harm, but on the contrary, sheltering it; and these may therefore be very properly left for a time. This at once points out the harm that would be done to plantations were we to thin them according to any theoretical rules.

On this point also the theorist says, "At the first thinning, cut away all the four larches that stand next the hardwood in each case." Now, we have already said that when young hardwood trees are allowed to have too much space in the plantation, they naturally incline to spread their side branches, and do not grow so tall as they ought to do in order to make clean valuable timber. In such a case as this, much pruning would be necessary in order to keep the trees in shape and put them into balance; and this severe pruning is always injurious; and were we to cut away all the four larches at once, this would be the precise state of the hardwood trees. A single glance at the diagram will show the tendency of such treatment. The four larches stand at a little over 4 feet distance from each hardwood. Now, were these taken away at once, what a severe check would the hardwood receive! Before the thinning took place, these nurses were close upon, and some of them even touching, the branches of the hardwood plant; whereas by their removal there would be a space of 6 feet between the hardwood plant and each of the Scots pines on the one hand, and another space of fully 8 feet between them on the other. This would not be nursing up timber upon right principles, but the very way to retard its growth.

1854. Having, we think, pointed out the evil which would arise from going to work in forestry according to theoretical rules, it is evident that practical experience is the only schoolmaster for the person who is to mark the trees which should be taken out of a plantation at any period of its growth; and seeing that no invariable rule can be laid down as a guide, the operator may safely go to work conformably with the following directions:—

He will first provide himself with what is termed a *hand-bill*, with which to mark the trees which are to be taken out; and with this implement in his hand, he will take his station on the most sheltered side of the plantation to be thinned. Our reason for beginning upon this side is, that all trees have fewer branches upon what is termed the *storm side*, than they have upon the other; consequently, the nurses growing upon the storm side of the hardwood plants will have their inner branches, or those upon their sheltered sides, more abundant, and more lying upon the hardwood, than those which grow upon the sheltered side of the latter. Now, the operator, from keeping this in view, and beginning upon the sheltered side of the plantation, sees much more readily, as he advances, the branches of the nurses which grow upon their sheltered sides, and can more easily judge of the extent of the injury they may be doing to the hardwood trees.

Being thus stationed with a hand-bill for the purpose of marking, he will walk up to the first hardwood plant at the point where he intends to commence; and having done so, he will examine which of all the larch trees about it has its branches lying most upon it, and which will, without doubt, be the one that stands most directly between the hardwood plant and the storm point. Having decided upon this, and marked it with the bill, by simply breaking off a few of the branches, or by taking a *slice* of the bark from it, he will have a man or two following him, each with an axe, whose duty will be to cut each tree as it is marked. In the cutting of it, the operator will, with his axe, prune a few of the lower branches from it, in order that he may the more readily get his implement to the root of the young tree; and this being done, he will cut it as low as possible, beating away any of the grass with the head or heel of the axe, if that be any obstruction to his getting it cut sufficiently low. The tree, as soon as it is cut, should be hauled out by a boy present for the purpose, and laid down upon the nearest road in the plantation, where another boy should be stationed for the purpose of taking off all the branches with a hand-bill. Small trees of this description should be pruned out to the very points, and put in bundles or small lots, for the convenience of removal.

1855. We shall now suppose that one larch has been marked, cut, and carried out,—the one which had been hanging most upon the hardwood plant. Now, from this one tree having been removed, the person whose duty it is to mark the trees will see more clearly how the hardwood trees may be affected by the removal of the one. He will after this be more able to judge as to which of the others should be taken next; and if the branches of any of the other three larches, which are yet supposed to be growing about the hardwood plant in question, are found in any way to hang upon, and are likely ere long to injure it, let it be marked and cut away also.

1856. At this early stage of the growth of such a plantation as we are now speaking of, it will very seldom be found necessary to cut away more than two nurses from each hardwood plant, and in many instances even one may be enough to take away at once, with the view of retaining a regular proportion of shelter throughout the plantation, as well as of doing justice to each hardwood tree. Therefore, at this stage, we would advise that where any of the larches are not encroaching upon the branches of the hardwood plants, nor likely to do so for the next two years, they should be left till the next period of thinning, which, according to the scheme laid down in a former section, will take place three years afterwards. By such a cautious method of procedure the trees will succeed much better, and not receive any sensible check.

1857. In the same manner as has already been pointed out for the relieving of the first hardwood tree, do to the whole in the plantation, paying no respect to the nurses themselves, but having the attention constantly directed to the relieving of each and every one of the hardwoods. The nurses, in this instance, are merely planted with the view of rearing up the hardwood plants; and when they begin to hurt them by pressing too close upon them, they must, of course, be removed. The person who marks the trees need not wait in all cases till he sees the one which he marked cut down,—this would be a tedious business; but if he has never marked any trees before, as we are at present assuming he has not, it is but proper that he should begin cautiously, and see the effects of his judgment before he proceed too far. This he may properly continue to do for a day or two; by which time, if he is an intelligent and observant person, he will be able to go on marking before the cutters. He may now and then take a walk back upon the ground he has gone over, and see the effects of his work; and if anything presents itself that he could improve upon, such as marking a few extra trees which may appear to be too close upon the hardwoods, this will have the effect of improving his judgment in the work he has on hand, and make him more attentive in future. In marking the trees, let it be done invariably upon one side; for if this be not attended to, the person who comes behind to cut them will lose much valuable time in looking for the marks; while, if the trees are all marked upon one side, he will have no difficulty in finding them out.

1858. After the trees have been all carried out and pruned of their branches, as has been already directed, they should be removed from off the roads by means of a horse and cart, and stored in any convenient part until sold. If they can be sold beforehand, so much the better, as by this means considerable trouble will be saved in their not having to be carted and stored past at home. The size of these larches, at about ten years old, will, in a moderately exposed situation, 800 feet above the level of the sea, be from 10 to 12 feet in length, and from 2 to 3 inches in diameter at the middle.

1859. In three years from the time that the plantation had received its first thinning, it will again be necessary to look over the hardwood plants, and take away from them all the larches that seem to approach and hurt them. At this second thinning it is very possible that all the latter will require to be taken out; for if we now suppose the plantation to be of thirteen or fourteen years' standing, the Scots pines which stand within 6 feet of the hardwood (see Diagram) will be strong and healthy young trees, and will, from their massy foliage, prove shelter enough to the hardwood. This, however, must not be taken as a rule; for even at this stage, upon any prominent high part of the plantation, it is very possible that the hardwood trees may not have advanced so very rapidly as might be imagined. In such cases, therefore, it will be proper to leave a few of the larches till the next course of thinning, in order to shelter the hardwood and bring them into shape; for if they be exposed at this stage, they will not be easily got into shape afterwards. But in all moderately level parts of the plantation, and more particularly in any hollow, all the larches may at this time be, without hesitation, taken out; while, by the time the plantation has arrived at 17 years of age, the larches may all be dispensed with, leaving the nearest trees to the hardwood—namely, the Scots pines—at 6 feet distance from them (see Diagram). In taking out all the larches, have the work done exactly as we have already described for the first course of thinning—except that, when they are come of a pretty large size, they will require to be pruned of their branches on the spot where they fall, and the trees carried out to the roads, while the branches can be gathered up and disposed of afterwards.

1860. In practical forestry it is found that the whole number of the trees that may have been originally planted upon the ground cannot be accounted for in the course of thinning and training up; and this observation we make here, in order that the inexperienced may not have too sanguine hopes as to the results of after-profit. Having now had the management of thinning a vast extent of woodlands at all possible ages, and having kept accurate notes of the results of each as we went on, we have found that, even under very good management, 8 per cent will be found amissing when the season of thinning commences. The reason of such deficiencies occurring is, that while the plants are in a very young state—say during the time that they are under 5 years of age in the plantation—they are liable to be attacked by vermin of every description, such as hares, rabbits, mice, squirrels, moorfowl, &c. &c. Hares and rabbits destroy young trees, both nurses and hardwood, by gnawing the bark upon the stems and branches. We have often seen young trees, three-quarters of an inch in diameter, completely cut through by such vermin—consequently such trees were rendered useless if of the pine and fir tribes; but of course hardwood trees, although gnawed over, would again come away from the bottom part. Mice and squirrels injure young trees by eating out the buds. If the winter and spring happen to be a severe one, they also peel the bark from young trees wherever they can reach it; and when severe frosts set in, trees so injured very frequently die in consequence of the frost affecting them at the peeled part. Moorfowls are very destructive to young Scots pine plants, by picking out all their principal buds: and from this cause alone we have seen very many young trees rendered useless. It will thus appear evident to the young forester that he must not be disappointed although he cannot find all the trees which he knew were originally planted upon the ground.

1861. At this stage of the growth of the young plantation, the method of training up which we are now endeavouring to explain, it is necessary that the forester should examine if all the hardwood plants are really worthy of being kept as the permanent crop; and in examining this let him be particular, not so much as to the shape of each plant, as to the state of its health. In every case where a hardwood plant does not appear to have made young wood freely for some years past, and is of a stunted habit of growth (and this will sometimes occur), let him cut it away and give place to one of the nearest nurses—this being a larch if possible, as it will ultimately become of more value than a Scots pine would do, provided the soil be suitable. It is also, from its upright habit, better adapted to stand as a permanent tree among hardwood. All the above points having been attended to, it will again be necessary, at 16 years—that is to say, if the plantation was thinned for the first time when 10 years old—to look over the whole; for at this stage a number of the Scots pines will be encroaching upon the hardwood. These should be taken out, on the same principles as already detailed regarding the thinning out of the larches; the attention not being directed to the taking out of any given number of trees from each of the hardwood, but merely taking out those that are really pressing upon them, or likely to do so within the next period of three years. By going to work regularly once in three years with this course of thinning, by the time that the plantation has arrived at 22 years old, every one of the Scots pines which were growing at the distance of 6 feet from the hardwood will have been removed, thus leaving one Scots pine plant standing in the centre of the square formed by each four of the hardwood plants; consequently at this age the hardwood will be 8 feet from the nearest Scots pine in each case. (See Diagram.)

1862. By the time that the plantation has reached 25 years old, the hardwood trees will be all of a strong healthy habit, and very probably may average 30 feet in height, with an average diameter, at 5 feet from the ground, of 6 inches, having abundance of moderately strong leafy branches upon them for two-thirds of their height. Now, at this stage of the growth of hardwood trees they ought to give prospect of their future worth. In the state above mentioned, the remainder of the Scots pines should be allowed to stand till the oaks are about 25 years of age, when another thinning should be commenced, by taking the Scots pines away from the oaks. This thinning, too, as well as all the former ones, should be done gradually, and not all at once; and we may say that, in general cases, by the time that the plantation is about 30 years old, every nurse, excepting, indeed, any that may have been left instead of any bad hardwood, should be removed from among the hardwood, leaving them among themselves at 12 feet apart (See Diagram.)

1863. In any high and exposed point of a plantation, it is wisdom in the forester to have a considerable portion of the nurses left standing. They are more hardy than the hardwood sorts; and, when growing upon an exposed site, such as the outside and towards the storm-point of a wood, they form a protection to more valuable trees in the interior. In the act of thinning such parts, where it is considered necessary to have the nurses left, it must be kept in view to have a portion of the hardwood taken out, and nurses left in their place; as, of course, they could not grow up all together.

1864. As it is, from experience, found that all the hardwood trees do not advance at the same rate, we may remark here, that even at the time that the last of the Scots pines are being taken out, it may be found necessary, in sheltered parts of the plantation, to take out a few of the hardwood also. Of course this will take place in such parts as were first relieved of the Scots pines; for in sheltered parts, and upon a pretty good soil, the very same circumstances that cause the rapid advance of the nurses will cause a similar advance of the hardwood. This point also must, therefore, be kept in view by the intelligent practical forester; and in taking out a few of the hardwood trees at the stage we are now referring to, he will first carefully note which sort has the appearance of attaining the most valuable development as an ultimate crop upon the ground. In the case now under consideration, we shall suppose that sort to be the oak; consequently, in taking out any of the hardwood trees at the period referred to, care must be had to see that they are given every advantage to. Again, at the same time, care must be taken to see which sort of the hardwood trees is the most unhealthy, and has the least chance to become of a healthy and valuable size. We shall suppose this to be the ash; and being satisfied upon this point, the forester must act accordingly, taking out the ash as the first thinning of the hardwood. By this method more space will be given to others that have the appearance of becoming more valuable upon the ground.

1865. In the cutting down of the Scots pine trees from among the hardwood at the advanced stage of about thirty years, great care must be taken to see that no damage be done to the hardwood by their falling upon them, In order to avoid this, it is only necessary to have the pruning-chisel at hand, and by means of it to take off any heavy branches from the nurses before cutting them down; and when their tops are lightened by this means, an expert woodman will cause them to fall to any given point very exactly, which point must, of course, be that of the greatest opening in the neighbourhood of the tree to be cut down. In carrying out trees that have been cut from a plantation at the stage we are now referring to, the work should be entirely performed by a few men, and no horses should be allowed to draw them out, as is often done, to the great damage of many of the standing trees. This damage is occasioned by the cut trees, while being roughly drawn out along the ground, coming in contact with the stems of the standing ones, and taking the bark off them. At the stage now referred to, therefore, the cut trees should be carried out by the woodmen, either upon their shoulders as they may be able, or by means of handspokes, to the nearest part of the roads.

1866. As the hardwood trees will all be making rapid progress between 32 and 36 years of the age of the plantation, we shall now suppose that, by the time it has arrived at the latter-named period, all the ash-trees have been removed for the purpose of giving ample space to the oaks. It will be observed, by looking at the diagram, that the ash-trees are situated alternately with the oaks in one line, while the sycamores are situated in like manner with them on the other line of view. Ash-trees, at the age we are now referring to—namely, at from 32 to 36 years old—are in a very fit state for many country purposes, and particularly for handle-wood; and will, if growing in a favourable soil and site, sell at a good price. Again, by the time that the plantation has attained 40 years of age, it will next be necessary to have the greater part of the sycamores taken out, leaving the oaks at about 24 feet apart. It may be necessary to remark here, that in taking out the sycamores it may in many instances be found advisable to leave one near to an oak of a weaker growth, and, at the succeeding course of thinning, it can be decided which should remain as the permanent tree. This matter must be left to the judgment of the forester in charge. But, with the view of illustrating the case now before us, we shall suppose that the sycamores have all been removed, and the oaks left 24 feet apart from each other on the one hand, and about 17 feet from the elms on the other. (See Diagram.)

1867. In the course of five years after—say when the plantation is about 45 years old—it will be necessary to have the greater part of the elms taken out also. At this stage they will be of good value, and fit for coach naves, trams, and many other valuable purposes. In removing the elms, as well as in the case of the sycamores, it may be found necessary to leave a portion, as we already explained relative to the sycamores; for no thinning of the trees should be done suddenly, or to exact rule: in many cases the whole may be required to come away for the sake of the oaks, while in others a few may be required to remain for a time longer. In the present case we shall suppose that by the time the plantation has attained the age of 50 years, the trees in general will be left standing at about 24 feet apart from each other all over the ground. Hardwood trees, of 50 years old, standing at 24 feet apart, will have ample room to develop themselves in a vigorous healthy manner for 6 years, and till they are about 56 years old, when another course of thinning will in all probability be necessary; and at that stage, if they have succeeded according to expectation, a few trees will probably require to be taken out in order to relieve others of a more vigorous growth. In this case no rule of distances can be given, for the trees will in some instances be very close upon one another, and in others, according to their growth, they may have quite enough of space, and stand freely. In the same manner the plantation may be gone over regularly at periods as occasion may require, till there are left upon the ground about 50 trees per acre, which will in all probability be when they are about 80 years old. They may then most properly be left for a period of other 20 years, which would make them about 100 years old, at which age they will be suitable for any purpose for which large oak is required.

1868. In all cases where it is considered necessary to take out the roots of large trees in order to convert the land into agricultural fields, the roots should be taken out with the trees at the same time they are taken down. By this means a great advantage is gained, by having the tree as a lever for lifting the roots out of their places; consequently the work can be much cheaper done than if the trees were cut over by the surface, and the root allowed to remain till the trenching of the land took place.

1869. What we have said above relative to the rearing up of hardwood plantations, is only applicable to them when grown for the sake of their timber; but upon proprietors' estates hardwood plantations are more generally raised with the view of being ornamental upon the lawns and home parks, than simply for the sake of the value of their timber.

Every proprietor who lays out new grounds in the neighbourhood of his mansion-house, if no plantations exist upon those grounds at the time, will, in accordance with good taste, and with the view of affording shelter, plant extensively upon them. And every proprietor of sound natural taste will, in a case of this nature, plant the different sorts of hardwood, with the view of their becoming ultimately his permanent standing trees, and make up with the common sorts of coniferous ones, simply with the view of acting as nurses, until the hardwood sorts arrive at a size sufficient to insure their welfare, independent of them.

1870. We are aware that many proprietors, whose seats are upon high-lying and rather moorland districts, are of the opinion that hardwood trees will not grow with them to a size worth cultivating with the view of becoming ornamental lawn-trees. Upon this point our experience points to quite a different conclusion. In all high-lying situations, where the Scots pine and spruce firs are found to succeed well—the former on the heights and the latter in the hollows—the beech, oak, elm, and ash will thrive well also, and become trees of no mean magnitude. This we have observed in the northern parts of Scotland, as also on the highest-lying districts in the south of Scotland and north of England; therefore no proprietor, if he can produce upon his estate Scots pines of good size, should hesitate to plant the kinds of hardwood trees above named. All that he has to do, in order to insure success, is to plant Scots pines or larch as nurses along with the hardwood, and remove them by degrees as the others advance.

1871. It is allowed by all people possessed of good natural taste, that pines, when planted in a mass, and forming a plantation near to a proprietor's mansion, without a proper intermixture of hardwood trees, give that place a cold, heavy, alpine appearance, although it may be situated in the most fertile part of the country. And it is our opinion that every proprietor of land should endeavour, as much as possible, to cultivate all the different sorts of hardwood within the range of his home parks, which will give his grounds a fertile and cultivated aspect, although the situation he may occupy be naturally one of an opposite character. All plantations of coniferous trees—excepting, of course, such specimens of the different kinds as may be reared for variety and ornamental effect—should be kept out upon the poor high grounds of an estate; and by the arrangement of having the hardwood trees chiefly in the centre of the property, and the others upon the outer grounds, the whole will have a most natural and imposing effect.

1872. Wherever a young plantation is made of hardwood and pines, with the view of their ultimately becoming ornamental park-trees, they should, in every respect, be treated in the same manner as already advised for forest hardwood trees, until they arrive at the period when they require to be thinned for the first time. The hardwood which are intended for lawn or park trees should have, at all stages, much room and space to spread out their branches and develop themselves according to their nature, which is the state in which trees always appear to best advantage. In order to allow the young hardwood trees to attain their natural shape as much as possible, the nurses which may be planted about them should be kept well off them, and never allowed even to touch their branches, but placed so as merely to stand by their sides, and give the benefit of their shelter. As soon as they approach each other closely, the nurses should at once be sacrificed. At the same time, however, care must be taken that this is done gradually—perhaps looking over and taking out a few every year, as occasion may require, and as the hardwood trees advance.

1873. The great art in rearing up hardwood trees for lawn scenery is, first, not to prune off any branch after the trees are fairly established in the ground, and about 10 or 12 feet high. Second, the sorts which act as nurses should never be allowed to spread themselves upon the branches of the hardwood, but should merely stand by for the sake of shelter. Third, observe what sorts of hardwood trees appear to thrive best upon the ground, and encourage those most which appear to do best; and at the same time, wherever any particular sort of hardwood does not appear to do well upon the soil, leave pine, fir, or larch in their place: a few good specimens of those look well among hardwood in any situation. Fourth, when the hardwood trees have advanced so as to require all the nurses to be removed to give them room, and when they begin even to encroach too much upon each other, cut out several of them also, and continue to do so until the trees have attained the age of 60 years, after which period it will not be found necessary to thin much, if they have been well attended to previously. Fifth, in the act of thinning out trees intended for park and lawn scenery, care should be taken that picturesque openings be made here and there, for the sake of distant objects to be seen from the mansion—such as a particular plantation upon a height, a romantic view of an old ruin, or a sheet of water in a neighbouring hollow; all of which are beautiful objects in landscape scenery, and should never be hidden from the mansion and grounds of the proprietor; for however beautiful trees may be in themselves upon a lawn, they form but a dull and monotonous scene if well-chosen openings are not left among them, through which other interesting objects may be seen.

SECTION VII.—SYSTEM OF THINNING AND REARING OF MIXED PINE, LARCH, AND FIR PLANTATIONS.

1874. In order to point out properly the manner of proceeding with the thinning of mixed pine and fir plantations, it will be necessary to give a detailed account of how the work should be done at the different stages of the age of any plantation; and as we have already stated that no particular age of a young plantation can be given as that at which thinning operations ought to commence upon it, the observation of the operator must always be his guide in such a case.

Every man who has given his attention to the rearing of forests must have observed that on some particular soils and situations a young plantation may be in a fit state for thinning at 8 years of age, while another, composed of the same sorts of trees, and planted at the same time, may not be ready for this operation at 10 or even 12 years' standing; all depending on the elevation of the situation, the nature of the subsoil, as that is open or retentive, dry or damp, and also in a great degree the extent of the plantation itself. Therefore it is that observation upon the spot is the only decisive way of ascertaining when a plantation is in want of being thinned.

1875. For the guidance of those who may not have had much experience in the thinning of pine and larch plantations, we shall here lay down a few hints of practical utility, from which we are certain a cautious, intelligent man may be enabled to lay the foundation of future experience in this art. In examining the state of a young pine and larch plantation with the view of ascertaining if it be in a condition so far advanced as to admit of being thinned, it will be necessary first to walk very carefully through its whole extent, and mark well the bearing which the young trees have one upon another. If the points of the lower branches of the young trees be merely touching, or slightly interfering, with one another here and there, thinning would be premature, and ought to be put off for a year longer; but if, upon examination, the lower side branches of the trees have the appearance of having been somewhat checked in their growth from the want of freedom and air, and if the higher branches of one tree are spreading widely, and actually encroaching upon those of another, it is high time that thinning should be commenced. If the lower branches of the young trees have a brown and deadened appearance, and the upper are spreading so widely that in many instances the points of the strongest of them reach nearly to the stems of others, thinning has been delayed too long; and from the trees being heavy topped, and light in the lower parts, many of them would be apt to be blown down if thinned suddenly: therefore thinning should never be delayed so long as to allow the last-mentioned feature to manifest itself upon the trees.

1876. Having in the manner stated gone through the young plantation, and determined as to whether it ought to be thinned or not—supposing that it has been found requisite to thin, it will be necessary, previous to commencing operations, to examine which sort of tree has thriven best upon the ground, and has the appearance of becoming the most valuable for a permanent crop of timber. Thus, if the ground has been originally planted with a mixture of pine, larch, and spruce firs, examine each district of the plantation as it may naturally divide itself into height or hollow, sloping banks or level ground, and ascertain which kind appears most healthy, and is most likely to come to perfect maturity as a timber-tree in each separate district. In each district spare that species which, from general appearance, is most likely to succeed well; and when thinning, remove those sorts which have not the appearance of becoming good timber upon the soil.

1877. In the act of thinning, particular attention should be paid to leaving, in all cases, the healthiest trees upon the ground, and to cutting out those that are most weakly, as the nature of the thinning may require.

1878. In thinning a plantation, many foresters think that the principal object to be aimed at is, that of giving the whole a regular, systematic appearance, by leaving the trees as nearly as possible at a given distance one from another, without taking into consideration the ultimate welfare of the plantation. Such a method of conducting thinning operations may, indeed, have the effect of pleasing the eye and taste of the inexperienced for a time; but the effect is certainly ruinous to the proprietor in the end, and is never practised by the forester of extensive experience. If the trees in a young plantation are all equally healthy, then it is but proper to thin them out to a regular distance from one another; but where many of the trees appear of an unhealthy cast—which is frequently the case in most situations—the healthy trees should be preserved without respect to a nice regularity in appearance. Wherever two trees may be found growing together, the one healthy and the other unhealthy, and, according to regularity in the act of thinning, the unhealthy tree may be found to occupy a proper place, and the healthy one an improper, yet, for the sake of the future welfare of the plantation, there should be no hesitation as to which should be cut down. In all such cases, at once cut out the sickly and leave the healthy.

1879. In the thinning of young mixed pine and fir plantations for the first time, it may be asked at what distance the trees should be left the one from the other? No certain distance can be specified: for this reason, that the young trees do not all grow alike in the same plantation, either as regards height or breadth of branches; consequently, they do not all occupy the same space upon the ground. In the first thinning of any plantation of considerable extent, it will often be found prudent and necessary to pass over some parts altogether, without taking out almost a single tree—and this will happen upon a part of the ground which is of a poor thin nature; while again, wherever the ground is of a stronger nature, with a little shelter from the higher grounds, it may be found necessary to take out nearly one-third of the trees in order to give proper air and room. All this must be regulated by observation more than by any rule that could be given. As a general rule, however, our own method of procedure is, to leave the trees, as nearly as possible, *free from one another* after the thinning has been performed: that is, when a plantation of young trees has been newly thinned, the extreme points of the branches of one tree should be quite free from those of its nearest neighbour; and in all cases where coniferous trees are raised for timber as well as for shelter, they should be kept rather close together than otherwise.

1880. No pruning of pine, larch, or fir trees should be allowed: pruning invariably deteriorates the quality of the wood of such trees, and their health also is much injured by it. If the trees are kept somewhat close to each other, they naturally prune themselves as they advance in height; for as soon as the lower branches of the coniferous tribes become confined, and a want of free air ensues in the body of the plantation, they gradually die and fall off, without in the least injuring the quality of the timber. All the ends or stumps, however, of dead branches, should be carefully removed from the stems of pine, larch, and fir trees, and that as soon as they become deadened—this tending to make the quality of the wood much finer.

1881. In the act of thinning, great care should be taken that no large open space be left among the trees, which in any direction would in length measure more than the height of one of the trees growing by it. This can easily be avoided by proper attention in the disposal of the trees upon the ground, not to have them running in rows, but in such an alternate manner that, which way soever the eye looks from any given point, there may be always a tree to intercept the view within a short distance. This, indeed, is a point of the utmost importance in the art of thinning plantations, and can only be attained by careful observation and experience. If open spaces be left for any considerable distance, the wind gets play among the trees, and has a tendency to cause havoc among them, particularly after being newly thinned, and the more so if the plantation has been formerly neglected. As soon as the young trees which were marked to come out have been cut down, they should be carried out entire to one of the nearest roads in the plantation, and pruned of their branches there. This is not, indeed, always done; but still it ought to be the method of going to work among young trees, the health of which requires free circulation of pure air among them.

1882. Supposing that a plantation of young pine, larch, and fir trees had been thinned in the manner above recommended, when about ten years old, the trees would then, probably, be 15 feet high on an average; and supposing that the same plantation was then in a fair state of health, and to have continued so for another period—say of 3 years from the time that it was first thinned—it would, at the end of this second period, be about 13 years old, with the trees from 18 to 24 feet high; and they would, in all probability, be ready at this age for another thinning. In the thinning of the same plantation a second time, the same practical points relative to the work must in all cases be attended to as have already been recommended for the first thinning; consequently these need not be repeated here. But there are one or two points which must be observed by the operator in the thinning of plantations approaching to or about 20 years old—the first of these being, to see that the standing trees are not injured by the falling of those that are cut down. We have seen much damage done to the trees in a young plantation, where the falling down of the cut trees was carelessly conducted; and it cannot be too strongly recommended to all operators, in the act of cutting down any tree of considerable size and height, to be most careful in the operation. When a pine or fir tree happens to lose its top by a felled neighbour coming in contact with it, such a tree seldom or never increases any more in height, and frequently dies. The operator, in the act of cutting down any tree of such weight of branches as may be considered dangerous to let fall against any of its neighbours, should, if he has not a sufficient opening for its safe fall, provide himself with a pruning-chisel having a shaft proportioned to the height of the tree, and also a mallet; and with these he should lop off all the heavy branches from the tree to be felled, previous to its being cut. When it is thus made bare of all its branches, any tree of 15 years may be at the command of a man's strength, in so far as he may be enabled to push it down to one side or another as he may see fit, to suit an opening among the standing trees. The lopping off the branches from a tree of any considerable size, in the standing state, is, however, an operation requiring considerable time; consequently it need not be adopted excepting in extreme cases, where there is evidently danger to the young and growing trees.

1883. In most cases an expert woodsman can, from observation and practice, make a tree fall very nearly to any given point he may choose as an opening of the safest description. The method practised by expert woodsmen in this sort of work, is to observe, first, toward which side the tree he may be about to cut has naturally its centre of gravity. Having ascertained this point, he proceeds to judge if the tree will or can be made to fall into a proper opening among the growing trees; and being from observation well assured as to the side to which the tree can be made to fall with the most safety, he commences to cut first upon the side to which he wishes it to fall. After cutting rather more than half through upon that side, so as to throw the centre of gravity in the desired direction, he next applies his axe to the opposite side. As he gradually weakens the perpendicular attitude of the tree, he observes now and then if the centre of gravity in the tottering tree is likely to take an unexpected turn upon him; and if so, he checks the same by cutting oppositely. By these means alone we have had men who could lay down trees upon the ground to almost any given point. But, notwithstanding all this, we have frequently had to do with instances in the thinning of plantations where the coming down of a heavy-topped pine or fir tree would have done much damage; and in such cases, when we applied the chisel in the manner above stated, the work was safely accomplished.

1884. At the age proper for the second thinning of any mixed plantation of coniferous trees, it should never be too severely thinned; because at such an age—say at about 13 years old—the trees are generally in a very healthy and rapid state of growth; and if they should happen to be checked at such a stage, the ultimate value of the whole plantation might be materially impaired. Hence it is requisite, in all cases, to thin with experience and caution.

1885. It is always better to thin frequently, and take out a few trees at a time from any given plantation, than to thin at distant periods, and then to do so severely. After any young plantation has been thinned for the first time, it is advantageous to its welfare to go over it and take out a few trees in the way of thinning at intervals of three years. At such thinnings we would advise every forester merely to take out such trees as are really doing injury to others. By this method plantations never experience any sensible check, and, consequently, they are kept in a constant quick-growing state; whereas, by the method of thinning at irregular intervals, and without system, they are generally allowed to stand unthinned too long, and thereby the trees in a plantation are frequently hurt to a very great extent from the effects of confinement.

1886. Every plantation of the mixed description under notice ought to be gradually thinned as the trees advance in height and breadth, until they are from 45 to 50 years of age, after which period no such plantation which has been properly managed should be at all disturbed by the operation of thinning, excepting the taking out injured, unhealthy, or decaying trees. At from 45 to 50 years of age, the trees in a mixed pine and fir plantation should stand at such a distance one from another as may be considered sufficient to bring them to confirmed maturity upon the soil upon which they are growing.

1887. At about 70 years of age, the wood of the pine and fir tribes is generally considered to be in its most valuable and solid state as timber. It is then heavier and more full of resinous matter than at any other stage of its existence; consequently, at that age if the object be a crop of valuable timber, the tree should be cut down, and disposed of as may seem best. But if the proprietor have in view the giving shelter to his lands, which is generally one end aimed at, the plantation may be allowed to stand for other 20 years, after which period the trees will begin to become lighter in their wood, and many will then be showing marks of natural decay, and the whole plantation will of course be, generally speaking, of less value than it was at 70 years' standing. However, this is not always the case, for very much depends upon the nature of the soil and situation upon which the crop of wood may be growing, as to whether the land may be suitable or unsuitable, dry or damp, and as to whether the situation may be high or low lying. On high situations, with suitable and dry-bottomed beds, pine-trees will grow improving till about 100 years old; while, on the other hand, where they are grown on low and humid sites, they show symptoms of maturity at a very early age.

SECTION VIII.—SYSTEM OF THINNING AND REARING OF PINE PLANTATIONS.

1888. Plantations consisting of several kinds of trees intermixed, whether hardwoods or coniferous trees, are always more difficult to manage judiciously in the way of thinning than such as consist of one species alone. Hence it is found, generally speaking, that it is most advantageous, in respect to the ultimate value of a crop of trees, as well as saving in the expense of training, to plant the crop of a plantation as much as possible—taking all circumstances in connection with it into due consideration—of one sort of tree only; and if of more than one sort, in masses of each separately, to suit soils and situations.

1889. In reference to coniferous trees, each of them, as well as the hardwooded sorts, has its own peculiar habit of growth,—the larch being of an upright airy habit, and its light branches having very little tendency to injure other trees standing near it: the spruce and silver firs, on the other hand, are also of an upright habit, but from their throwing out stiff, horizontal branches, densely clothed with hard persistent leaves, they invariably injure other sorts standing near them, if not kept within due bounds; while the pine, being naturally disposed to throw out strong and pendulous branches, is also apt to injure any other tree of a more slender habit of growth. When, however, each of these kinds is planted in masses separately, from the habits of all the trees in each mass being alike, the one cannot injure the health of the other nearly so readily as when composed of different sorts, where those of a stiff unbending habit, such as the firs, invariably have a tendency to encumber such as are of a more pliant habit, as both the pine and the larch. We make these remarks to show that a great advantage is gained by planting trees in masses of one sort, both in respect to the general health of the crop itself, and in respect to the less amount of attention and expense necessary to be bestowed in training, and also to show that the thinning of plantations composed of pine alone, or of any other sort, is a much more simple operation, and requires less judgment in the operator, than when they are composed of several kinds of trees.

1890. In planting trees in masses of one sort, however, a much greater degree of judgment is necessary in the planter to adapt the sorts to the soil suited to them than is generally called for in the case of mixing several sorts together; as if the one tree planted should not be properly suited to the land, a partial or an entire failure might be the result, while if several sorts had been intermixed, some one of them would be sure to succeed. This point, then, demands the serious consideration of the planter.

1891. In thinning a plantation consisting of pine alone, from the trees being generally of a uniform habit of growth, the work is comparatively of easy performance, and only requires proper attention to remove, at each course of the operation, such of the more weakly trees as encumber or interfere with the development of the more healthy and promising ones.

1892. The whole of the plantation should be gone carefully through as each successive thinning falls to be made; and wherever the trees encumber one another, a judicious selection should be made of the strongest and most promising to stand regularly over the ground, at proper and consistent distances apart, according to the age at the time, and all inferior ones should be removed, so that after each course of the operation every tree shall be left standing quite free of its neighbours in the spread of its branches, but no more.

1893. In thus thinning a pine plantation, the work should be begun on one side of it, and proceeded with by taking on regular belts—in breadth according to the number of hands employed—from the one fence to the opposite one, till the whole is gone over, and no part should be neglected or overlooked. In going over the plantation in this way, all rough and unpromising trees should be removed, and well-grown ones left instead, as rough branchy trees of the pine tribe are never valuable as timber; and any trees that may have lost their tops by accident should be removed also, as such cannot possibly make good trees afterwards.

1894. After the thinning of any one plantation has been completed for the time, and after the produce of it has been removed, all drains should be scoured out, so as to leave them in good operative state,—care being taken, in the act of thinning, to prevent branches falling into them; and after the felled trees are all removed from the enclosure, the roads should be made good, so as to present a uniform, neat appearance.

1895. There is no season of the year so advantageous for the thinning of plantations as the months of March, April, May, and June; as when the operation is performed within these months, the crops operated on have the advantage of the summer weather afterwards to grow freely, and to attain a greater vigour of health before the storms of winter set in upon them, and as the opposite of this must follow to the trees in a plantation thinned in the autumn.

SECTION IX.—THINNING AND REARING OF FIR PLANTATIONS.

1896. The cultivation of the fir tribe in this country is on a small scale as compared with that of the pine, few plantations of any considerable extent ever being made exclusively of it, but only portions of large enclosures, where few other trees would grow so profitably as a crop; as in the case of the spruce on moss land, and the silver fir on moist-bottomed soils, for growing on which situations these trees are admirably fitted. The timber of both these firs is, however, valuable when grown of proper dimensions; and as the waste parts of the country are cultivated, and partly put under trees, we find this class well adapted to grow usefully when properly planted in groups on land suitable for them in large enclosures. We therefore consider it may be proper to devote a short section to the manner of thinning and rearing these trees, not so much with a view to describe all the routine of their culture—as that is generally very much the same as the culture of the pine tribe—as to point out any peculiarity in reference to them that may be necessary to attend to in the mode of thinning them.

1897. Compared with the larch and pine, the fir is of slow growth during the first three or four years after it is planted out, but after its roots become properly established it makes very rapid progress—not unfrequently 30 inches of upright shoot in one year—and generally outstrips the pine after the first six or eight years.

1898. The roots of the fir keep nearer the surface of the land on which they grow than any other coniferous tree we are acquainted with; hence they succeed well upon a thin surface-soil, although cold and somewhat wet in the bottom. From this peculiarity, however, the trees are very apt to be blown down by severe gales of wind, if not judiciously attended to in respect to thinning. In order to prevent this, they should at all stages be kept pretty far apart from one another, so as to allow of the free and undisturbed spread of both their roots and branches, as no other condition is so likely to keep them in perfect health, and prevent them being blown down.

1899. In commencing to thin plantations, whether of spruce or silver fir, great care must be taken not to delay the operation till the branches of one tree interfere with those of the other, at least to such an extent as to impede their healthy action ; as if so, the branches, from their being naturally slender and comparatively weak, will suffer in health, and consequently fail to keep the trees in that degree of health which is absolutely necessary for their full development. This point, then, should be most carefully attended to, and thinning commenced before the points of the lower branches of the trees begin to interfere with one another. At each successive thinning the same point should be carefully attended to, and every individual tree kept apart and distinct in every respect from its neighbours.

1900. The silver fir will endure a greater degree of confinement, without much injury, than the spruce; but both are extremely impatient of want of space. In rearing timber of the pine tribe, it is in practice found desirable to check the luxuriant growth of the branches, as, when unchecked by judicious confinement, they become unduly strong, and lessen the value of the timber. This is not the case, however, in regard to the firs—and this forms the great distinction between them: their branches, although freely exposed on all sides, never become so strong as to interfere with the upright growth of the leading stem,—not even so much as to impair its fullest development, but rather the contrary; for we invariably find that the more the branches of the firs are encouraged by having space, the larger and the better is the timber of the trees. These are the only points we think it necessary to advert to in regard to the rearing of the fir. They are important, however, and, if not attended to, the trees will be comparatively weakly and unsightly as a crop, as well as valueless as timber.

SECTION X.—THINNING AND REARING OF LARCH PLANTATIONS.

1901. In planting a large piece of land exclusively with larch, the planter should be very careful to ascertain first that it is in every respect adapted to grow the tree to valuable size, as no tree we cultivate is so easily injured in health when planted on an unsuitable condition of soil. From this tendency of the tree, the greater number of planters at the present day seem more disposed to use it as a nurse to hardwoods, or as an intermixture with the pine and fir, than as a tree to be planted exclusively as a crop. This is a mistake, however, in the forestry of the time, as can easily be proved from the excellent crops of larch found growing in a sound and healthy state, in all varieties of soils, and in all situations, wherever the condition of the land is either naturally, or has been rendered artificially, suited to it. This condition consists simply and mainly in the land being of *a deep, open, and porous description,* and the particles of which the soil is composed being *kept in a clean and wholesome state* by the ready passage of rain-water through it.

1902. There are indeed few soils on which the larch may not be grown satisfactorily, provided that their thorough drainage is attended to previous to planting. The great mistake in regard to the cultivation of the larch in this country has been the planting of it on lands in which were lodged ingredients prejudicial to the healthy growth of the tree, and which had not been cleansed away by the action of drainage. This is a fact not now to be doubted, as on all soils that have been properly opened up, made porous, and cleansed by drainage, larch is found to succeed satisfactorily, even although on the same soils it failed to grow previous to drainage. From our experience on this point, therefore, we recommend proprietors not to be deterred from planting larch extensively, even without the intermixture of any other tree, provided the land is thoroughly cleansed by the action of a well-applied system of drainage some time previous to planting.

1903. The land intended for larch having been well drained, and allowed to lie under the action of the drains for one, two, or three years, according as it is naturally open or otherwise in the subsoil, it should next be planted with that tree, say at four feet apart, and when the plantation has attained from 8 to 10 years' growth, it will probably be so far advanced as to stand in need of thinning for the first time. This thinning should be conducted in every respect as detailed in reference to the thinning of the pine.

1904. The larch being a tree clothed with slender branches and soft delicate leaves, is easily injured by confinement. The trees therefore require, at all stages of their growth, to be kept apart from one another in the plantation. If this point is not attended to, and the trees, especially when under 30 years of age, are allowed to become crowded, their roots and branches will both become weakly and impaired in their healthy action, and the result will be *rot in the heart.*

1905. The larch is at all stages extremely impatient of confinement; hence we find in the greater part of mismanaged plantations of this tree, the branches, for a considerable way up the stems, either dead, dying, or diseased, and the trees only struggling for existence by having air and light for their tops. In such a state no tree can possibly grow healthily, and from this arises much of the disease in the tree we hear complained of.

1906. At each successive course of thinning a larch plantation, the object should be to leave the branches of every tree standing perfectly clear of all those of its neighbours, so that each tree in the plantation may stand in every respect unencumbered on all its sides.

1907. After each successive thinning has been performed, all branches that may have died should be removed, by simply breaking them off close to the stem with any blunt instrument. But what is of far more importance to the health of the crop, is to have all drains thoroughly scoured out, and every one left in a clean and fully operative state. This latter point is too little attended to even by the most intelligent foresters, and hence, to a very large extent, the cause of the generally inferior crops of larch. It is, in fact, no uncommon thing to find the drains in a plantation left uncleaned after it has been thinned, with large quantities of branches lying rotting in them, and causing stagnant water. Under such a state of things no tree could possibly grow satisfactorily.

SECTION XI.—SHOULD TREES BE GROWN IN MASSES OF EACH KIND SEPARATELY, OR MIXED SEVERAL KINDS TOGETHER IN A PLANTATION?

1908. In the eighth section of this chapter, where we refer to the rearing of pine plantations, we stated that, "generally speaking, it is found most advantageous, in respect to the ultimate value of a crop of trees, as well as saving in the expense of training, to plant the crop of a plantation as much as possible—taking all circumstances in connection with it into due consideration—of one sort of tree only; and if of more than one sort, in masses of each separately, to suit soils and situations." As these statements were made chiefly with respect to the growing of coniferous trees, we think it necessary to devote a few paragraphs to the fuller consideration of the subject brought forward, and as it is stated in the heading of this section.

1909. If we take nature for our guide in the rearing of the trees we cultivate, we shall find that in the natural forests the pines for the most part grow in masses of each kind separately, while the larch and firs do the same, although not so decidedly—each family associating together on certain spots or districts, according to the suitableness of the soil of these to their natural wants. We have visited the great natural forests of Canada and the United States of America, for the purpose of ascertaining the habits and peculiarities of trees as they are found when growing on a large scale in a state of nature; and as the result of our observations in respect to the habits of pines, firs, and larch, we are led to state that the opinions we had formerly entertained and acted upon relative to them have been in all respects confirmed—that is, these kinds, for the most part, are found each congregating separately in masses, and seldom mixed with any other species. On dry ridges and knolls we invariably found the Pinus strobus in extensive and dense masses by itself, with here and there small masses of the Pinus resinosa adjoining; while on the wet flats we found the larch luxuriating, also in masses by itself, with here and there groups of arborvitæ adjoining. The picea and abies we found occupying every variety of soils and situations, from dry hill-slopes and banks of rivers to rich and somewhat wet soils on level parts of the country; and these kinds we seldom found in large masses separately, but generally either in small masses, or mixed with hard-wooded trees of various kinds.

1910. The hardwood kinds of trees we never found growing in masses of each kind separately, at least to any important extent. Indeed, in all our examination of the natural forests of North America, we never found even the extent of a few acres occupied by one single species of hardwood. The different families of oak, ash, elm, maple, beech, lime, birch, &c., associate together in all proportions of intermixture, according as the condition of the soil is suitable for them respectively. On light sandy soils the beech and sugar maple are found to prevail; on soils of a strong loamy nature the oak, elm, plane-tree, and lime are the chief trees; on land of a cold wet nature the ash is generally found to prevail; while the birch is found in all the conditions of soil named. From what has been stated, then, it is to be inferred that in a state of nature—and there we always find the best timber of whatever kind—the pine family is found chiefly growing in large masses of each species separately, and upon the higher-lying and poorer portions of the land;—that the larch also is found growing in masses by itself,—of course, we do not here refer to the European larch, which is a tree of a very different habit from the American species—still in its own native habitat it is found to grow in masses separate from other kinds, the only difference between the two species being that the one luxuriates in a dry soil and the other in a wet one;—that the picea and abies families naturally occupy a very much wider range of soils and sites than the pines and larch do, and are found to associate extensively with the hardwood kinds;—and that the hardwoods do not generally grow in masses of each sort separately, but are found chiefly growing intermixed with one another, in various proportions, according to the suitableness of the soil to the respective species. These remarks now prepare us for giving an answer to the question stated as the heading to this section, which is as follows:—

1911. All the different species of pine and larch should be grown in masses of each separately, excepting in so far as trees of another species may be required to be planted with them as temporary nurses for a time; as, for example, if it is found judicious to plant Pinus laricio as a permanent crop on a certain district, then plant this tree at 10 feet apart as a permanent crop, and make up with larch among them as nurses to 5 feet over all; the latter tree, being a temporary one, meant to be removed in the way of thinnings, will not interfere with the healthy progress of the permanent crop, but must rather add to its ultimate value by its open and light habit admitting more air to the pines in their young state than they could have had, had the whole crop been planted of pines alone.

1912. The picea and abies tribes may be planted either in such masses of each sort separately, or intermixed with each other, or with hardwoods, as the nature of the land or taste may suggest.

1913. The hardwood sorts may all be planted intermixed, or each kind may be planted in a separate mass by itself, according as the soil and site may be found suitable for each species respectively, and according as the taste and judgment of the planter may suggest.

1914. The three immediately-preceding paragraphs contain the answer to the question put as the heading of this section. The answer is based on the usual laws of nature in respect to the known habits and peculiarities of trees; but we have still to refer to it from an economic and an ornamental point of view. First, then, in an economic point of view: as each family of trees has its own peculiar habit of growth, when the members of each family are planted in masses separately, from the habits of all the trees in each mass being alike, the one does not injure the other nearly so readily as when composed of different kinds, and in consequence a great advantage is gained by planting trees in masses of one sort, both in regard to the general health of the crop itself, and in respect to the less amount of attention and expense necessary to be bestowed in training. And, besides, it will in all cases be found that where trees are planted each kind in a separate mass by itself, and each kind in that soil and site which are found most conducive to its healthy development, a greater bulk of available timber is produced from each acre occupied, and consequently a greater revenue from it, than could be taken from a crop of a mixed description. We have very frequently observed this, both in the natural and artificial forest; and it is worthy of the notice of all planters to take this point into careful consideration before commencing to plant on any piece of land.

1915. In referring to the subject under notice from an ornamental point of view, we must, however, simply state our conviction that the planting of trees in masses of each kind separately has a bad effect in the landscape of any place, especially when carried out to any considerable extent upon it; therefore this principle should be carried out only in dealing with outside plantations which are reared for shelter and profit, and should never be admitted in regard to planting on parks or lawns, where judicious groupings and blendings of species, so as to produce variety of foliage, in every manner of way, and from every point of aspect, should be the object in view.

1916. One other point in connection with this subject requires yet to be brought under notice; and that is, where trees are planted in masses of each kind separately, great judgment is required in the planter to give each species that soil which is best adapted to its healthy development; as, where this is not attended to, and unsuitable plants put on the soil, great disappointment must ensue, and ultimate little value in the crop. When a crop is mixed up of several kinds of trees, it generally follows that at least one or more of the kinds are found to prosper on the land, and from this state of things a crop can generally be secured although some of the kinds fail; but where the trees are of one kind only, and that kind has been planted on an unsuitable soil, there is no alternative but to clear, and afterwards replant with a tree suitable to it.

CHAPTER XV.

SECTION I.—MANAGEMENT OF HARD-WOODED PLANTATIONS OF CONSIDERABLE AGE, REARED CHIEFLY WITH A VIEW TO ORNAMENTAL EFFECT.

1917. The relative condition of trees in a plantation of considerable age—say about 60 years—and reared avowedly with the design of their forming clothing for the home park of the mansion of an estate, will depend altogether upon the training and management they may have been subjected to previously. If they have been regularly attended to, and systematically thinned in the way which has been advised in former sections, they will, by the time they are about 60 years of age, be fine, healthy, and well-developed trees of their several kinds, every one standing clear of and unencumbered by another, and still making progress. But if they have not been attended to in this way, they will, at the age stated, in every probability be tall of stem, small topped, and weakly, from crowdedness and consequent want of air.

1918. Where trees have been properly attended to and well thinned while in their young stages—say especially while from 15 to 40 years of age—there is comparatively little danger of their getting wrong afterwards, as the strength of constitution which such management secures for them enables them to resist the effects of after mismanagement to a wonderful extent, as we have had frequent opportunities of witnessing in the case of woods that had been well managed while under one proprietor, and afterwards neglected when they fell into the hands of another who paid little attention to such matters. Where, on the other hand, trees have been neglected while in their young stages, no after-system of management, however judicious, can possibly be of much benefit to them.

1919. Assuming that plantations of the hard-wooded sorts of trees, reared with the object of their becoming ornamental specimens on the park and its neighbourhood, have been attended to and properly thinned up to the age of 60 years, the only after-management necessary is to clear away from time to time any inferior tree, as it seems to interfere with or encumber a better one in its neighbourhood, to bring any very fine specimen more decidedly into view, by cutting down others that stand near it and intercept the view of it from particular points, to relieve the masses by grouping here and there on well-chosen points, and by partial clearings on others between, and to keep all the trees clear of such branches as may happen to die from time to time.

1920. Where plantations of hardwooded trees, occupying the position of ornamental ones, have been neglected while in their young stages, it is impossible, as we have said, that any system of management can recover them to any considerable extent; but of course this remark is only applicable according to the degree of neglect that the plantations may have existed under; as, if they have been partially attended to, the crops will of course be partially recoverable, while, if they have been allowed to grow up in an utter state of neglect as to thinning, the case is without remedy.

1921. The only sensible way to improve the crop of a neglected plantation, and which it is found desirable to preserve as long as possible, in order to keep good the amenity of the neighbourhood, is to single out all the most healthy and promising trees in it, and immediately afterwards to relieve them of all such inferior ones as encumber them. This, however, must be performed with judgment, and gradually, as any sudden removal of a large number of the inferior ones would have the effect of ruining the whole. In endeavouring to recover the better trees of a neglected plantation, therefore, so as to preserve them for ornamental effect, the smaller ones proposed to be removed for relieving them must be taken out gradually, and not all at once. By attention to this we have seen the crops of neglected hard-wooded plantations very much improved; but much of the success always depends upon the selection that is made of the trees for standing, before thinning commences; as, if weakly-rooted trees are left, with comparatively heavy tops, they never succeed, but become still more weakly after the inferior trees are removed.

1922. A plantation of trees managed on the principle of allowing every one in it to stand clear of and unencumbered by any of its neighbours at all stages of its growth, always becomes more valuable as a crop, is more ornamental, and lives to a greater age, than one managed differently. This is a fact based on the laws which regulate the vegetable kingdom, which we are daily in the habit of observing, and yet which many do not seem to take advantage of. In illustration of the point we may ask, Why is it that trees found standing alone on parks grow on for even two and three hundred years in a healthy condition, while those in crowded plantations become matured and die at a very early stage? The answer is clear:

in the case of the former class the trees had full room to extend their roots and branches in order to keep good their health; whereas in that of the latter the roots became diseased and weakly at an early stage from want of food, and their branches were smothered, and therefore failed to act for the maintenance and support of the trees.

SECTION II.—MANAGEMENT OF PINE AND FIR PLANTATIONS OF CONSIDERABLE AGE, REARED CHIEFLY WITH A VIEW TO ORNAMENTAL EFFECT.

1923. Although large masses of pine and fir are generally objected to in the immediate neighbourhood of the seats of landed proprietors, from their too dark and sombre effect, they are not, in any undulating and hilly district, objected to when grown on the tops and higher slopes of the background, as on such sites they, from their producing a clothed and massy appearance at all seasons, give the landscape such a grand effect as is not attainable by the presence of hard-wooded sorts alone; and from this we generally find plantations of pine and fir, on extensive properties, cultivated with a view to their being kept up as ornamental, independent of the timber they produce.

1924. In training up plantations of these sorts, whether mixed or separately, with the view of their standing for ornamental effect, the trees should, at all stages of their growth, be kept much farther apart from one another than when trained up for the sake of their timber alone; and this in order that they may develop themselves in their natural and true habits, both in regard to stems and tops. In doing this, however, they need not be kept so far apart as to cause the specimens to become of an extremely rough and branchy habit, but only to such a degree as to insure their not being drawn up; and this state of the trees is generally secured by keeping them at distances from one another nearly equal to their average height.

1925. If pine and fir plantations are trained up in this way till they have attained 50 years' growth, they will require very little attention in the way of thinning afterwards, as the trees will, by the time they have arrived at this stage, have become generally well-developed specimens, and will therefore only require to be relieved by times, as a few of the superior specimens may want more space for the greater spread of their branches, or as a portion of the inferior ones may show a tendency to encumber the better. This will be found all that is necessary for promoting the healthy maturity of pine and fir plantations after such an age as is now supposed; provided, of course, that the trees have been properly trained.

1926. When such plantations as we are speaking of—pine and fir of 50 years of age—have been neglected while young, and have been drawn up and the trees rendered weakly in consequence, there is little hope of their recovery by any system of management afterwards; but of course, in reference to this, as well as in the parallel case of the hard-wooded sorts, the recovery will be in degree according to the extent of the neglect. Still from experience we find that equal degrees of neglect in hard-wooded plantations, and in pine and fir ones, are attended with very unequal degrees of recovery to improvement afterwards. The crop of a hard-wooded plantation, although it has been much neglected, will improve wonderfully if skill be applied to the thinning of it, while that of a plantation of pine or fir of the same age, and equally neglected, will not only not improve at all, but will, on the contrary, go back the more quickly when thinning is attempted. Therefore, when it is found desirable to improve a neglected pine or fir plantation, more judgment is necessary for success in the work than in the case of a hard-wooded one.

1927. To improve a neglected plantation of coniferous trees, the same mode of thinning should be followed in regard to it that has been recommended for the recovery of neglected hard-wooded plantations, and as detailed in paragraph 1921. When, however, the trees left do not seem to improve under the operation of thinning in two or three years after it has been commenced, the better mode is to clear them altogether, and to replant.

1928. The spruce and silver firs, as well as the larch, are more easily injured by confinement than any of the pine tribe we are acquainted with, and this in degree according to the nature of the soil and site they occupy. In a dry and open subsoil the pine maintains its health for a long time, although grown in a crowded state; and on such a soil it recovers wonderfully when judiciously thinned after long neglect, while on a soil of an opposite character it can scarcely be improved at all in such circumstances. The spruce fir and the larch, if neglected to be thinned when grown on a light soil with a retentive bottom, soon become unhealthy, and heart-rot succeeds; while, on the other hand, they will keep very much longer in a healthy and growing state, under the same degree of neglect, when grown on a heavier soil with a porous bottom. We make these remarks in order that the inexperienced forester may be the better enabled to judge as to how far the different species referred to are likely to improve after neglect, according to the nature of the land they occupy; for, after all, very much of the success attending the thinning of neglected plantations of any sort, will be found to depend upon whether the land is naturally well suited to the trees, or the contrary.

SECTION III.—MANAGEMENT OF HARD-WOODED PLANTATIONS OF CONSIDERABLE AGE, REARED WITH A VIEW TO SALEABLE TIMBER ALONE.

1929. In the first place, it is worth noticing in reference to the difference betwixt the rearing of hard-wooded trees with an especial view to ornamental purposes, and that of the same sorts with the view of their becoming timber for sale only, that in the case of the latter less space is necessary for each tree grown, as large tops and branches are not so much the object of the cultivator as the quantity of available timber in the stem, and therefore a larger number can be reared on a given extent of land.

1930. A plantation of any sort of hard-wooded trees, if it had been dealt with, up to the age of nearly 60 years, in the way that has been described in a former section of this book, will require very little attention from the forester, other than removing from time to time any inferior trees, as such encroach upon others of a more promising and valuable description.

1931. In the management of plantations consisting of mixed sorts of hardwoods, all of considerable age, the forester will have to see that the more spreading branched sorts, such as the ash and the elm, do not interfere with the full development of the oak in particular, which is more easily injured by such encumberers than almost any other tree.

1932. Although, generally speaking, a greater number of trees may be properly grown upon a given extent of land, when intended to be cleared as a crop of timber, than when intended for permanent ornamental purposes, still great caution and judgment are necessary to be exercised in this respect by the cultivator, as, if the crop should be allowed to become crowded, a very great loss of timber would be the result; because, under such circumstances, the trees would be drawn up weakly, and consequently would become premature. This, then, must be guarded against, as, in fact, much of the value of the crop ultimately depends upon whether the trees are allowed sufficient space to develop themselves healthily. The only sensible rule that can be given for guidance in this respect is to allow each tree sufficient space for the healthy action of its branches and leaves, but not to such an extent as to encourage the spread of the branches at the expense of the stem.

1933. A great encouragement to the healthy growth of all trees in masses is to keep the land in a dry, porous, and wholesome condition; and this is highly promoted by the thorough drainage of all wet parts, and of all those having a retentive subsoil, and by keeping all drains at all times in a clean and thoroughly operative state.

Without attention to this, the trees are sure to become diseased in their roots, prematurely old, and therefore worthless in the quality of their timber.

SECTION IV.—MANAGEMENT OF PINE AND FIR PLANTATIONS OF CONSIDERABLE AGE, REARED WITH A VIEW TO A CROP OF TIMBER ONLY.

1934. The most valuable description of pine timber is that which is most free from branch knots, and of the greatest diameter and length of stem. To secure these points, it is found necessary, in the cultivation of the trees for timber, to keep them standing at such distance apart from one another as is found conducive to check the too luxuriant growth of branches, without injuring their healthy action, and thereby throw the greater tendency of the sap to the formation of timber in the stems. Much as it is desirable to attain these qualities in respect to the pine, great caution is necessary to be used in its cultivation, as most foresters are more apt to grow the trees in too crowded a state, and thereby deteriorate the crop both in quantity and quality.

1935. In the management of pine plantations of upwards of 50 years' growth—keeping in view what has just been stated as desirable points in their cultivation for the sake of timber, and supposing that they have been generally well attended to previously—there will be found very little to attend to other than the removal, from time to time, of such inferior trees as are found to encumber more promising ones, as by the time the trees have attained the age referred to, they will be nearly all of confirmed habits of growth, indicating their result when at maturity.

1936. If the plantation of pine trees is large, and the land favourable to their rapid and healthy growth, there is a great tendency of the crop to become crowded and drawn up, the shelter of the mass being conducive to this state. When this is the case, the regular and systematic courses of thinning should be carefully continued to a later stage than would be necessary under a contrary state of the crop; the forester, therefore, should attend to this, and see that at all stages, while the trees continue to make considerable progress, they are not allowed to become crowded, or to interfere with the healthy action of the branches of one another; and especially, if the plantation is large, attention to this is requisite.

1937. To show that it is desirable to grow pine plantations on the principle of judiciously checking the growth of the branches of the trees, in order to induce the finer quality of timber in the stems, we may state that, taking any two trees of equal dimensions, the one of the rough and branchy habit of growth, and the other of the contrary, the timber of the former would be at least of one-third less value than that of the latter—thus making a vast difference on the value of a plantation of considerable extent.

1938. We stated in a former section that the branches of the fir are not naturally disposed to grow so strong as to interfere with, or affect the quality of, the timber—unless, indeed, the trees are allowed to stand so far apart as to be uninfluenced by each other's shelter; in which case they do become somewhat rough, from the excessively strong branches they produce: and that, if the full and healthy development of their branches is prevented, the health of the trees is impaired in consequence. This point, then, must be kept in view at all stages of the cultivation of the fir, and all that is necessary to secure the full health of a crop of these trees, when grown on a suitable soil, is to thin in such a way as to keep the branches of each tree from encumbering those of its neighbours. We find very few plantations of fir anywhere cultivated on the principle here set forth, and the result is that for the greater part, by the time they have arrived at the stage we are referring to—from 50 to 60 years—they are drawn up, diseased, and comparatively worthless as a crop, either for ornament or for use as timber. From this it is generally considered that the fir lives only from 60 to 70 years in a healthy condition. We could, however, prove the contrary, as we have cut healthy, sound, and growing firs upwards of 90 years of age; and this was where the land was well suited to them, and where they had stood at all stages free and unencumbered, and clothed with branches nearly from bottom to top. Where, therefore, it is desirable to cultivate fir trees to the greatest possible value, and so as to stand healthy as long as possible, the points we have stated must be attended to.

1939. The larch also requires full space for the spread of its branches, in order to grow it to perfection. In fact, few trees are more easily injured than the larch by confinement; therefore at all stages the trees should be allowed ample space for the spread of their branches, as from inattention to this point many plantations have been rendered comparatively worthless that might, had they been dealt with as we here suggest, have been of very great value to their proprietors. In making these remarks, we do not of course mean that the trees should be allowed to stand far apart from one another, in order to insure their branches being kept healthy. Such a course would result in a great loss of crop on the land occupied. We only mean that the trees should not be kept so close as to interfere with the healthy action of the branches of each other. This state of the trees is easily attainable under skilful management in regard to systematic thinning while comparatively young, and by judicious attention to relieve the crop of inferior encumberers after the trees have attained considerable age, and till they approach maturity.

SECTION V.—REARING AND MANAGEMENT OF PLANTATIONS FOR A SUPPLY OF HOP-POLES.

1940. Poles for supporting hops in hop-fields are procured from various sources,—partly from coppice-shoots, partly from thinnings of young plantations reared with a view to timber, and partly from crops of various sorts of trees, planted and reared expressly for the purpose; and in all cases the price varies according as the wood of which they are made is of a description calculated to last a long or a short time, and also in proportion to the size or length of the poles.

1941. Shoots of oak, sweet-chestnut, sycamore, and ash, are all used for the purpose when they are found of suitable lengths in coppice-woods; but the poles of such sorts being of a soft and comparatively perishable nature, do not bring such a high price in the market as those of larch, which last very much longer. Even Scots pine is used for this purpose, but the larch is preferred to any other wood in most cases.

1942. As larch, from its durability, when young, is found to give the most profitable description of hop-poles, in rearing plantations exclusively for the purpose, no other tree should be planted, as it always, when well grown, brings the highest price in the market.

1943. There are two modes of growing the larch for hop-poles. One is, to plant the young trees at distances varying from 18 to 30 inches apart, according to the size of poles wanted, and to let them grow undisturbed till they are of the size wished, and then they are cut all over and disposed of at once. The other mode is, to plant the young trees at 18 inches apart, and when they have arrived at a stage suitable for the smaller size of poles, to thin out each alternate tree, and leave the others to grow for some years, until they are fit for the larger sizes. Either of these modes may be adopted, according to the class of poles that may be found most in demand in the locality. In Woolmer forest and its neighbourhood large quantities of young larch are reared for this purpose; and they are there planted, some fields at 18 inches apart, others at 20 inches, others at 24 inches, others at 30 inches, and others at about 3 feet apart,—all depending upon the character of the poles it is wished to grow, whether of a small size or of a large one; of course the smaller the poles are wanted the closer the trees are planted.

1944. There is no class of tree crop more simple of cultivation than this, as the only point aimed at is that of obtaining the largest quantity of clean, straight poles, from a given piece of land; and this is attained by planting the young trees closely, in order that they may draw up one another to the desired length.

1945. It is often found desirable to rear several crops of this sort in succession on the same piece of land; and where this is an object with the cultivator, it is requisite that the land should be trenched at the outset, as by doing this the young trees will grow more rapidly, and therefore be fit for the market some two or even three years earlier than if they had been planted on uncultivated land; and of course from this a great advantage is gained, both in point of time and in that of the smaller amount to pay as the rent of land occupied by the crop. In preparing the same piece of land for a second crop of hop-poles, it should be trenched—and all the roots taken out in the operation — some 18 inches deep, so as to bring up new land and bury the old surface which had grown the first crop. This done, a green crop should be taken from it after manuring, when it will again be in a state properly fitted to grow a second crop of poles, which, from being planted on manured land, will grow rapidly, and repay any outlay in this respect. This may be done successively, one crop after another, for any reasonable length of time, as it is not timber that is wanted, but mere poles from 10 to 20 feet in length.

1946. On light, sandy, and poor thin land, in the south of England, we have seen Scots pine successfully grown for hop-poles. This was on land which would not produce larch in a healthy state to sufficient size for the purpose, being mere sand and gravel; and yet, upon it, the Scots pine grew well, and paid the proprietor amply, although a smaller price is given for pine poles than for larch. In fact, the poorest land possible may be converted into profitable bearing by rearing the pine on it for this purpose, as it is not necessary they should be grown to a size larger than 3 inches diameter.

SECTION VI.—MANAGEMENT OF GENERAL COPPICE PLANTATIONS.

1947. The raising of coppice plantations is of all others the most simple, and requires the least practical knowledge in the forester. Excepting oak coppice, this sort of forest cropping is seldom cultivated in Scotland; whereas in England it is very much cultivated, and forms in many counties a large proportion of crop grown in the form of wood. This is the more necessary, particularly in those inland counties where all kinds of fuel are scarce: there, where coal is high-priced, the inhabitants must resort to wood as a substitute; and in such cases all small rubbish in the form of wood becomes of importance.

1948. All coppice plantations must, in the first instance, be raised from young trees. The young trees, when planted for this purpose, ought to stand till they are from 5 to 6 inches diameter at the ground : this may be, according to the kind of trees planted, and according to the soil and situation upon which they are growing, at from 15 to 20 years of age. In order to convert a plantation of young trees into coppice, it is only necessary, when they have arrived at the stage mentioned, to cut them over by the surface of the ground, when, in the following season, they will send up from each *stock* a number of young shoots, these constituting what is termed coppice-wood.

1949. All trees do not equally possess the property of sending up young shoots from the collar of the stock; therefore the choice of the kind of trees is to be taken into consideration by the grower of coppice-wood. The fir and pine tribes do not send up shoots at all when cut over, and the beech does it but slightly. The kinds of trees best adapted for coppice plantations are, the ash, elm, oak, poplar, willow, chestnut, lime-tree, mountain-ash, maple, sycamore, birch, alder, hazel, and bird-cherry. These again, according to the uses they are generally applied to, may be divided into four classes—namely, first, *Coopers' ware and bobbin-wood*—ash, elm, oak, chestnut, maple, hazel, and sycamore. Second, *Charcoal-wood*—birch, alder, poplar, lime-tree, and mountain-ash. Third, *Bark for tanners*—oak. Fourth, *Basket-ware*—the willow. In the above division of the kinds of trees best suited for coppice, we have not included firewood, because all the sorts may be employed for that purpose, although not with like effect—the ash, oak, and birch being more useful than any of the other sorts; but as, in general cases, it is only the refuse of the coppice which is applied to the purpose of firewood, it is unnecessary to designate a class exclusively for that purpose. We may also state that, although we have mentioned mountain-ash as being adapted for charcoal, it is one of the best also for coopers' ware; and although we have included hazel among those adapted for coopers' ware, it is also excellently adapted for charcoal. Similar differences of application might also be stated relative to several others of the trees. In what remains of this section we shall point out the best method for the cultivating of each division, so as to produce the greatest possible crop upon the ground.

1950. In laying out a plantation with the intention of its becoming coppice, it is necessary to take into consideration what sorts of coppice-wood will sell to the best advantage in the neighbourhood;

and having determined this point, the next consideration will be, whether or not the ground to be planted is of a nature qualified to produce the kind which is in demand. This we would particularly draw attention to; for to plant those kinds of trees which are not adapted to the soil, although it should be well known that they would sell well when of size, would be the most effectual way of defeating the end in view. For example, were ash, elm, lime-tree, or poplar, planted upon a dry, light, thin soil, with the view of becoming profitable as coppice—or, on the other hand, hazel, mountain-ash, or birch, in a cold, damp, heavy soil—disappointment would assuredly be the result.

1951. Having fixed upon the situation upon which trees are to be planted for coppice, have it laid off, fenced, and drained, in the same manner as has already been advised for other plantations where it is in view to raise large timber.

1952. We shall suppose that a plantation of 500 acres in extent is laid out for this purpose, and that it consists of various hilly tracts, with a thin, poor, yet dry soil, with also considerable portions of good loamy soil, and in the hollows, mossy parts, which have been effectually drained of all superfluous moisture;—we shall further suppose that all sorts of coppice-wood sell to advantage in the country in which this plantation is situated; and by this means we will have the advantage of illustrating the whole system within the bounds of the one plantation.

1953. *First*, then—In all the bare hilly parts, the soil of which is light, and not more than a few inches deep, plant, at 6 feet apart, birch, mountain-ash, and hazel, and make up between them with larch or Scots pine to 3 feet over all. The latter are to act as nurses for a time, in order that the plants which are intended for the future coppice may grow up the more rapidly, and come the sooner into use.

1954. *Second*, Upon all the hilly parts which are less elevated than the first, the soil of which is of a deeper and better description than that on the parts lying above them, plant Norway maple, sycamore, oak, and chestnut, at about 7 feet apart, and make up between them with larch to 3½ feet over all.

1955. *Third*, In all the portions of good loamy soil having an elevation less than either of the two former tracts, plant ash, elm, lime-tree, poplar, and oak, at 8 feet apart, and fill up with larch to 4 feet over all.

1956. In planting the different sorts of trees in the different soils and situations above stated, each sort should be planted in a mass by itself, and by no means mixed, as is too often the case, to the great disadvantage of the crop in general. The latter system is the cause that, in general coppice plantations, where the kinds of trees have been promiscuously mixed in the first planting, we so often find so light a crop of the whole per acre upon the ground at the end of a given period. For example—were mountain-ash, birch, and hazel, all mixed together in a coppice-wood, the mountain-ash, from being a more rapid and luxuriant-growing plant than either of the others, would very much retard their growth, and hinder the development they naturally would attain under different circumstances. This we have very frequently had occasion to observe; and from the experience that we have had upon this point, we may state further, that were 3 acres planted with a mixture of the above three sorts, and other 3 planted each with one of the sorts separately, the latter would have, at the end of a given period, one-third more weight of wood upon it than the former. In all cases, therefore, each sort of tree, which is meant to stand as a permanent crop, should be planted in a mass by itself, and that to such an extent upon the ground as may be considered necessary. When coppice plantations are conducted on the principle of growing each sort of tree in a mass, another important point is gained—namely, that of each sort answering a certain purpose better than another at a given period, and therefore each division will be found the more valuable to any purchaser who may wish to buy coppice of a certain kind and size. For example, were a man to come to a proprietor of coppice plantations, and say that he wished a certain quantity of hoop-wood for the market, of a particular size, and if the purchaser saw 20 acres of hazel all of the proper size for his purpose, would he not give double the sum for it per acre, seeing it was so equal, which he would do for other 20 acres of a mixed character, from which, very likely, he could not get one-half of the wood to answer his purpose? The same may be said of oak coppice: a person might give a good sum per acre for oak coppice in a mass, while, if he found it mixed with other sorts for which he had not much use at the time, he might give comparatively little.

1957. In planting the permanent trees, let the greatest extent be given to such sorts of hardwood as are known to be most valuable and most sought after in the market, in so far as the nature of the ground may be qualified to bring them to perfection; and at the same time, with regard to the nurses which are planted for the purpose of producing a temporary shelter, let very few of them be of the evergreen sorts, such as pines or firs, but give the preference to the larch, because it is of a light and airy habit, and not apt to draw up the hardwood trees, as the more massy branches of the others are known to do. It is a bad feature in the management of young trees intended for coppice when they are drawn up tall and without proportionable girth. In converting young trees into coppice, it is most desirable to allow them to attain as much diameter at the *collar*, or that part of the stem situated nearest the ground, as possible; therefore, with a view to this end, the plants ought by all means to be sheltered so as to make them grow rapidly, but by no means so much as to draw them up. Were the hardwood plants allowed to grow without the benefit of nurses, they would be some years longer in coming into use as coppice; and besides, the spaces between them would be profitless to the proprietor; but when nurses are planted among the permanent hardwood, besides bringing them forward, they are of considerable value when cut down and sold as thinnings.

1958. In high exposed parts, where the hardwood plants are likely to suffer from the effects of storm, about one-third of the whole number of the nurses per acre may be pine; in less exposed parts one-fourth; and where the ground is generally of a sheltered nature, the whole of the nurses may be larch.

1959. In any hollow or mossy part of the plantation, where, from the dull inert nature of the soil, the other sorts of hardwood would not succeed well, have alders or birch put in, from 6 to 7 feet apart, according as the natural situation may be exposed or not. If exposed, have the ground between made up with Scots pines; but unless the ground have been thoroughly dried, the Scots pines will not succeed in such a soil.

1960. Having premised the above, relative to the disposal of the trees upon these different soils and situations, we shall now follow out the management which should be adopted during the growth of the trees to the period at which they are in a state for cutting over for coppice, and also state the manner of disposing of the crop as it comes to full age.

In rearing up a plantation of young trees for coppice, the forester must in this case, as well as in that of rearing up trees for timber, carefully guard against the hardwood plants in particular being choked by long grass, or any rank growths of weeds, during the first three years of their age: he must also be careful, as they advance, to have all nurses taken away as their branches approach those of the hardwood. In this case never allow the branches of the nurses even to lie upon the points of those of the hardwood plants; for if they are at all allowed to encroach, the latter will very likely be drawn up rather weakly, and consequently will not grow proportionally to diameter of trunk—the great point required in order to make a valuable coppice plantation.

1961. Having attended very carefully to keep the nurses duly off the hardwood plants, and having merely allowed them to stand by and give shelter to them for a time, the nurses will, by the time the plantation is from 10 to 15 years old, have been all removed from the ground; and at 20, or even 25 years, according to soil and situation, the hardwood plants will be from 6 to 8 inches diameter at the bottom, according to the sort, but not of a tall habit, having intentionally been kept in a rather exposed state. When they have attained this size, they will then be in a proper condition for cutting over for the purpose of being converted into coppice *stocks.* We are aware that, in the cultivation of general coppice plantations, many are in the habit of cutting over the young trees at a much earlier period than that mentioned above; but such a system of management is decidedly injurious to the future bulk of the crop, and tends to weaken the stocks rather than to strengthen them. We are decidedly of opinion that in moderately-sheltered situations the trees should not be cut over until they are from 6 to 8 inches diameter at the bottom; if cut over of a smaller size, the future crop will be proportionally lighter and weaker. By allowing the young trees to attain the size stated at the base before cutting over, they will afterwards send up strong and healthy shoots, while these will also be numerous; but if cut over of a much smaller size, the shoots will be few in number, and proportionally weak. We ought to remark here that the poplar and the tree willows will have attained the size stated long before the other sorts, and will therefore have to be dealt with preparative for coppice before the other kinds are ready.

1962. Having fixed upon the time or period at which the young trees in a plantation should be cut down as a preparation for future coppice-wood, the next thing to take into consideration is the proper manner of doing the work.

Several methods are in practice among foresters. Some cut them down with the axe, and leave the stocks in the sloping form represented in fig. 155, this sloping position of the stock being meant to throw the water off it, and prevent rot from taking place. We object to this method, because, in the cutting over of a young tree by repeated strokes from an axe, the stock is much damaged, and apt to be split longitudinally; consequently rot is sure to commence early. Fig. 156 represents another method frequently practised, which is to cut over the tree by means of the saw, leaving the stock flat on the top. We object to this method also, because, when they are cut over in this manner, from the circumstance of the stock being flat on the top, rain is sure to lodge upon it and cause rot at an early age. Fig. 157 represents the form in which all stocks should be made which are meant to keep sound, and produce a healthy crop of coppice, and is that which is employed by all superior foresters. The following is the method of procedure:—

Fig. 155.

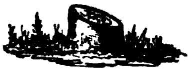
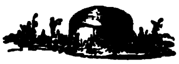


Fig. 156.

Fig. 157.



1963. Have a young lad with a sickle, such as is used for cutting down grain, and cause him to go before the men who are to cut the trees, and clear away all long grass, &c., from the base of each tree to be cut. This he should do to the distance of about 2 feet all round each tree; and in doing this he must be made to cut the grass as short as possible, in order that there may be no obstacle to having the trees cut low. When the boy has got the first tree cleared at the base, two men with a light cross-cutting saw follow him. The saw should first enter upon one side of the base of the tree, which of course should be the side to which the tree is intended to fall; and having cut at least 2 inches through upon that side, and about 2 inches up on the base of the tree from the ground, they then take out the saw, and cut the tree through from the opposite side.

Our reason for not cutting the tree through with the saw from one side is, that when this happens to be done—and it is too often done—and when the tree has just begun to fall, the bark upon the side of the tree opposite to where the saw was entered is liable to be torn away, with very often a part of the outer wood; and this will the more readily occur if there be a little wind blowing at the time—this almost invariably taking place before the men have time to cut the part clean through. Now this evil can at once be avoided, by simply cutting, in the first place, a part of the base upon the side to which the tree is to fall. In this manner the boy, with the two men following, will prepare and cut down the trees, observing to cut each stock so that it may be, as nearly as possible, about 2 inches high above the surface of the ground. Next in order, there will be required another man with an axe, whose duty is to prune the branches from each tree as it is felled: the branches, again, as they are cut off, are to be assorted for different purposes, according to the local demand; and as they are so, they should be carried out to the nearest road in the plantation, and laid in convenient lots, each according to its kind, in order for sale. The trees, also, as they are cleared from their branches, should be carried out to the roads, and assorted according to their sizes.

In this way the whole work of cutting down and carrying out the trees and their branches should be performed, taking care that the workpeople, in the act of carrying out the wood, do not put their feet upon their stocks; for by their doing so the bark would very likely be broken from the edges, which would of course be injurious to them. The work of carrying out the wood should therefore be carefully performed; and in order to see this done, a careful man should superintend it.

1964. The trees being all cut, and their produce carried away from a certain tract of ground, so as there need be no cause for apprehension of danger to the stocks, another man with a *sharp adze* will round the edges of each stock. In doing this, he must attend to go nearly down to the surface of the earth with the adze, taking with it both bark and wood, sloping it up neatly all round to the centre of the top of the stock. He must at the same time be most careful that the bark and wood have the same slope, for if this is not attended to, water may lodge upon the bark and cause rot there. He must also be cautious not to separate the bark from the wood.

1965. All the work relative to which we have now been speaking ought to be performed by the proprietor's own people, and not let to contractors, as is sometimes done, to the great hurt of the stocks, and consequently of the future crop of coppice. Another serious obstacle to the welfare of coppice-woods is, the bad practice that frequently prevails of allowing purchasers of coppice plantations to cut it down themselves. Now we beg to say that in the articles of sale the proprietors ought to reserve the cutting in their own hands, which would be greatly in favour of their woodland property.

1966. What we have said above is only applicable to those sorts of trees the wood of which is not used for powder-charcoal, nor the bark for tanning. Of course, in the cutting of the trees and the preparing of the stocks, the same rules are to be observed in all cases. But the oak, the bark of which is an important article, must be stripped as the trees are cut down. (For a description of how this work is to be performed, see section headed *Stripping and Drying of Bark used for Tanning.*) But even in the case of stripping, the wood must, in the first place, all be carried out to the road where the operation is to be performed. There is also the birch wood, the bark of which is used for tanning, and the wood for charcoal; and the alder, the bark of which is of no use, but the wood requires to be stripped before being sold to the powder-manufacturers. Hazel and mountain-ash are also much sought after by powder-manufacturers: the bark of these two is useless; but the wood must be stripped. In all cases of making common charcoal, it is not necessary to peel the wood for that purpose. We have made a considerable quantity of charcoal for colour and paint makers; and as it is not necessary that it be of so fine a quality as when used for gunpowder, it is generally made from wood with the bark on.

1967. As many foresters may have occasion to make charcoal for common household purposes, we shall here, for the guidance of those into whose hands this book may fall, give our method of proceeding.

The wood being collected near the place intended for the operation, and cut into billets, generally about 15 inches in length, the pits, or stacks, are generally formed in this manner:—A spot adapted to the purpose, of from about 12 to 20 feet in diameter,—according to the quantity required,—is selected, and being properly levelled, a large billet of wood, split across at one end and pointed at the other, is fixed in the centre of the area, with its pointed extremity in the earth, and two pieces of wood inserted through the clefts of the other end, forming four right angles. Against these cross-pieces four other billets of wood are placed, one end on the ground, and the other leaning against the angles. A number of large and straight billets are afterwards laid on the ground, to form a floor, each being, as it were, the radius of the circular area. On this floor a proper quantity of brush or small wood is strewed, to fill up the interstices, when the floor will be complete. And in order to keep the billets in the same position in which they were first arranged, pegs or stumps are driven into the ground, in the circumference of the circle, about a foot distant from one another. Upon this floor a stage is built, with billets set upon one end, somewhat inclining towards the central billet; and on the tops of these another floor is laid, in a horizontal direction, but of shorter billets, as the whole is intended, when finished, to form a cone. The whole is then coated over with turf, and the surface generally plastered over with a mixture of earth and sand. Previous to the operation of setting fire to the pile, the central billet in the upper stage is drawn out, and pieces of dry combustible wood substituted in its place, to which the fire is applied. Great attention is necessary during the process in the proper management of the fire, and in immediately covering up any apertures through which the flame seems to obtrude itself, until the operation be concluded, which is generally effected in the space of *four or five days*, according to circumstances. When the charcoal is thought to be sufficiently burned, which is easily known from the appearance of the smoke, and the tendency to flame no longer appearing through the vents, all the apertures are to be closed up very carefully with a mixture of earth and sand; which, by excluding all access of the external air, prevents the charcoal from being any further consumed, and the fire goes out of itself. In this condition it is suffered to remain till the whole is sufficiently cooled, when the cover is removed, and the charcoal is taken away. If the whole process is skilfully managed, the charcoal will exactly retain the figure of the pieces of wood.

1968. We shall now suppose that all the trees which were planted with the view of becoming coppice-wood have been cut over for the first time, in the manner which has been directed above, and shall now follow the progress a little in the coppice state, which is the end we have in view in the present section.

If the trees were all cut over in the months of February and March (excepting the oak, which must be cut in May or June, for the sake of its bark), the stocks will, by the middle of June, have sent up a large supply of young shoots from the collar all round. These are termed coppice shoots, of whatever kind the tree may be. In the autumn of the same year, the whole plantation which was thus cut over will form a coppice of one year's growth. Where it is intended to have valuable coppice, such plantations should have each stock thinned of all superfluous growths at the end of the second or third year, according to the rapidity and strength of the growths; but in general we may say, that when the coppice is of two years' growth, each stock should be thinned out, leaving from four to eight of the best shoots upon each, according to its strength to bring them forward. This should be done to every sort of young coppice. Allowing, then, that the stocks in the plantation have all been thinned at the above period, and the thinnings, as cut out from each stock, sold for hamper and crate stuffs, considerable profit will be at the time derived from those thinnings, without taking into calculation the superior value to be derived from the future crop by such a method of procedure.

1969. As to the period at which coppice plantations should be cut over, no definite number of years can be stated as sufficient to bring them to a certain size. For example, taking the oak as a standard in our calculation, in Herefordshire oak coppice is as bulky at ten or fourteen years as it is in Argyleshire at twenty or twenty-five years; and this points out that all depends upon the nature of the climate, the soil, and the shelter. Besides, as to the time of cutting down the crop of coppice, much depends upon the nature of the demand for the crop. Thus, in some parts of England, where much of the coppice is used for hamper, crate, and coopers' stuff, it is cut over at two and three years of age; in other districts where much of it is used for hop-poles, it is cut over at five and six years old; and in others, where it is used for fencing, and many other country purposes, it is cut over at from ten to fifteen years of age. In Scotland, again, where oak coppice is chiefly grown for the sake of bark and spoke-wood, it is left till it is from 5 to 7 inches diameter at the base. At whatever age coppice may be cut over, the work should be done by the proprietor's own people, allowing the purchaser to dispose of the wood as he pleases, unless, indeed, the latter can be properly bound to do the work on a right principle, and to the satisfaction of the forester on the place.

1970. In cutting over the coppice, the saw should in all cases be used where the shoots are above 4 inches diameter at the base; but when they are of a smaller size, they may very properly be cut over with the handbill, which should be kept in a sharp state for the purpose. In cutting away the shoots, they should be hewn closely in upon the swell at the base, and neatly rounded off, so as to present no inequalities or roughness for the lodgment of wet. At the same time, attention should always be given to keep the centre of each stock higher than the margin, in order to throw off the water and preserve them in a sound state. This can only be effected by the woodman, at every cutting of the coppice, dressing the stocks all round close to the earth, taking care, however, not to loosen the bark upon the tops of the roots; for if this be done, rot will be sure to take place there; nor should any earth be allowed to be put over the cut part, as this also would encourage rot.

1971. In the course of time, when several cuttings have been taken from the same plantation, it invariably happens, under bad management, that the stocks extend themselves to an extraordinary size, spreading themselves wide in circumference, and becoming rotten and hollow in the centre. This state of things should be guarded against; and under good management it seldom takes place to any large extent, at least for a very great number of years. The only way to prevent it is by cutting close to the old stocks at every period when cuttings take place, and being very careful to smooth over the whole, so as to prevent the wet from making lodgment upon it. In order to renew old and worn-out coppice plantations, the only sure and effectual way is to replant; and indeed this will be found in the end the most profitable way, at least in instances of extremely old coppice-woods. In all oak-coppice plantations, we find from experience that no cutting should be allowed after the middle of June—that is to say, if a healthy growth of young shoots is valued for a future crop.

1972. We now come to say a little relative to the value of coppice-wood as a forest crop. This of course must in all cases depend a great deal on the nature of the soil and situation upon which the stocks grow, and also upon the management they may have received while in their young state. Much as has been said by some authors relative to the great profits arising from oak coppice, we have not ourselves found this species of crop nearly so valuable to the proprietor as that of rearing the plants to full timber size; and from this circumstance we are led to recommend to proprietors the rearing of timber plantations in preference to coppice ones. From the experience we have had in the sales of oak coppice, 20s. per acre is about the average yearly rent of the land derivable from such a crop. Birch and alder coppice we have found to produce, at an average, about 18s. per acre; ash coppice, 30s. per acre. Coppice of a general mixed character we have never found profitable, seldom realising more than 12s. per acre per annum. The above valuations are taken from coppice cut down at periods between fifteen and twenty-five years. In Lancashire, even though there is a great demand for coppice-wood stuffs in Manchester and Liverpool, the land under such a crop seldom produces above 30s. an acre to the proprietor, while much oftener it is from 12s. to 20s.; and that, too, upon land which, if put under good forest management for the cultivation of timber, would without doubt realise three times the sum. Having witnessed this state of forest matters in England, we shall conclude this section by pointing out the manner in which coppice plantations might be converted into profitable timber plantations.

1973. In the converting of any coppice plantation into one which is to be trained up as timber, the sooner after the cutting of the crop of coppice this is had in view the better. The not having attended to this point is the cause that many coppice plantations, which have been turned into timber ones, have not succeeded according to expectation; the reason of the failure being, that the coppice was allowed to grow up in the usual manner, and until the usual period for the cutting of it, before a selection of proper shoots was made for becoming ultimately timber. With the mistaken view of taking as nearly as possible a full crop of coppice shoots from the stocks before converting them into timber-bearing ones, some foresters have recommended the system of leaving, at the time of cutting down the coppice, only as many good shoots as will ultimately become timber trees upon the ground, at distances from 20 to 30 feet, and advising, at the same time, to allow all the coppice stocks cut over to bring forth another crop, while the shoots that are left are becoming timber,—thus endeavouring to carry on both systems upon the same piece of ground, until those that are meant to become timber are large enough to fill the ground themselves. Than this, no system could be more certain to frustrate the end in view.

1974. The only sure way of converting a coppice plantation into healthy standing timber is this:—When the regular coppice has been thinned for the first time, say at 2 years old, have in view the raising of a regular portion of the best of the shoots for ultimate timber; and with this view, thin out all the weakly shoots and such as are badly formed, and leave none but the choicest, and those rather thinner upon the stock than if the plantation were merely thinned with the intention of its remaining under coppice. Having thinned the coppice rather severely at two years' standing, at four years' let it receive another good thinning, by taking away from each stock the worst of the shoots, leaving none but the best, and not more at that age of these than from four to five upon the most healthy of the stocks. At 6 or 8 years of age give another regular thinning; at about 12, a fourth; and at 15 years there should upon no stock be left more than one shoot, which is designed to be trained up as a timber tree. After this period, such a plantation may be treated exactly in the way which has already been directed for hardwood plantations. The advantages of this system are evident. First, The trees are trained up gradually and naturally, and never suffer any check; second, A better selection can be made, from there being a continual choice of shoots at the command of the forester as they grow up at different stages; and, third, By this method of selecting and training up, the plants, or trees as we may term them, at nearly 20 years old, will be twice the size that others would when merely chosen from the body of a thick coppice-wood and exposed all at once; and by the time that they are 30 years old they will be three times as large, and we may also add, three times more healthy and valuable.

1975. As cases may occur where proprietors may wish to convert a coppice plantation of some years' growth into a timber one, we may state, for their guidance, that at whatever age they may wish to do this, they should never commence to cut down suddenly, and expose the shoots they wish to rear up as trees. The only sure way in a case of this kind is, to select the very best of the shoots at proper distances from one another, and have them pruned and kept clear from the shoots upon the other stocks. Those also should alone be selected which appear to come away from the earth, and not those which have the appearance of coming away from the collar of the stock—for such never will come to make good trees. As those that are made choice of advance in size, give them room gradually, and eventually good standing timber may be formed in this way, cutting away all the rejected shoots betimes, in the same manner as in the case of thinning away nurses from among young hardwood trees in any other timber plantation.

1976. We do not mean to infer that all coppice plantations should be converted into timber-producing ones, as there are many districts in this country where coppice plantations are highly advantageous in many respects, and even more ornamental and valuable than timber ones could be on the same sites. What we mean is, that where coppice plantations are on land adapted to grow timber to valuable dimensions, and where these do not pay the proprietor a good return, it will be found very much more profitable to grow trees in the form of timber than that of coppice.

SECTION VII.—MANAGEMENT OF MIXED COPPICE AND TIMBER PLANTATIONS.

1977. Plantations of the description termed mixed coppice and timber are so common in many parts of the country, that this description of wood crop is of some importance upon the estates of many landed proprietors, and therefore it may not be out of place here briefly to detail the best modes of its management, more particularly with the view of pointing out the most profitable manner of going to work in the converting of old oak forest ground into healthy young plantations.

1978. When a plantation of old oak and other hardwood trees is cut down, and when it is the intention of the proprietor to convert it into a mixed coppice and timber plantation, the work must be proceeded with in the following manner:—First, the whole of the wood of the original trees, when cut down, should be removed immediately, as also all the bark taken from the oak portion of them, in order that no damage may be done to the young shoots as they arise from the newly-cut stocks; for, if the wood be allowed to lie long upon the ground after it is cut, the young shoots will have grown to a considerable height, and they, being extremely tender, will be easily broken in the act of removing the wood at a late period. In order, therefore, to prevent this taking place, if the wood have been sold to any neutral person, say in the winter time, he should be bound by the articles of sale to have the whole of both wood and bark removed by the middle of June at the latest. If this be not done, much loss will certainly be sustained in the after-crop of the coppice-growths, seeing that it is impossible to remove heavy timber from the ground without rolling it over the shoots in their tender state.

This part of the work is always best done by the proprietor's own servants, and under the superintendence of an experienced forester; because, in such a case, the people who cut the wood are paid by the proprietor, and being so, will look more to his interests, or at least will attend more to the orders given them, than strangers from a distance would do, whose only interest is that of getting the wood cut down at as little expense as possible, without any regard to the future value of the plantation. It is also necessary to notice here, that in cutting down any oak-tree, the stock of which is intended to push up young shoots for the formation of coppice, great care is necessary to see that the bark is not injured below that part where the tree is cut over; for if the bark be hurt and ruffled there, so as to separate it from the wood, moisture will be lodged between it and the wood, and consequently rot at that part will be apt to take place.

In order to prevent this, it is always a good plan, previous to commencing the operation of cutting down the oak portion of the trees, to employ a cautious, trustworthy man to go before the wood-cutters, who, with a *handbill* and wooden mallet, should be instructed to cut the bark right through to the wood, in the form of a ring, all round the circumference of the tree, fully 2 inches above the surface of the ground. The first ring being cut all round, another should be made in like manner 2 or 3 feet higher up on the bole of the tree, when the piece of bark situated between those two cuts can be removed, and the woodman made to saw each tree across exactly by the lower mark, or bottom of the peeled wood. This forms a guide to the men not to injure the lower part left with the bark upon it, as well as, when any difficulty is experienced in bringing the tree down, avoiding all waste of bark.

1979. As soon as the wood and bark have been removed, all rubbish and useless underwood should be carefully cleared away, excepting any young healthy shoots, or young plants which may be considered worth leaving upon the ground, with the view of their ultimately becoming trees. And immediately after the ground has been cleared of rubbish, the stocks of all the old trees should be dressed with the adze, in order to cause the young shoots to come away as low down and as near to the roots as possible. If the young shoots which are intended to grow up into coppice be allowed to proceed from that part of the old stock which rises 2 inches above ground, these shoots will always partake more of the character of branches than of trees, and never will make a valuable plantation; but if made to come away from that part of the stock where the roots join with the main stem, and which lies immediately under the surface of the soil, they will partake of the character of trees, and, independent of the nourishment that they receive from the parent stock, will also send out roots of their own, and derive nourishment from the common earth, and form pretty large trees if desired. Now, in order to cause the young shoots to issue from this point, the long grass should be all cleared away round the stock, and itself dressed off with an adze. In executing this, care must be taken that the part where the roots issue from the main stem be not injured; but supposing that 2 inches of wood have been left above ground upon the stock, the workman should commence by levelling his tool upon it fully 1 inch down upon the wood, and hew off this part all round, gradually lessening the depth of his cut as he nears the centre or crown of the stock, which is left untouched, thus leaving a fall from the centre to the circumference of fully 1 inch, and forming a convex crown. This form prevents the lodgment of moisture, as well as causes the young shoots to come away as near to the earth as possible, which should always be aimed at; and in this manner every stock which may be intended for the rearing up of coppice-wood should be managed. The sooner the operation is done after the trees are cut, the greater is the hope of a good crop of healthy shoots: the forester, therefore, ought not to delay this until all the other work of clearing away the trees and rubbish be finished. The whole ought, indeed, to be gone on with according to the time that we have above stated, but still the whole may be proceeding simultaneously. Our way of proceeding with work of this kind is: we have a party of men with horses and carts, who begin upon one side of the ground, and clear away all the valuable wood as they proceed. Immediately following this first party we have a second, consisting of women and boys, headed by a man to superintend them, who gather up all the rubbish that is left by the men with the carts, and carry it to convenient openings, and burn it at once, unless some other more valuable use can be made of it. The ground being cleared by this second party, we have a man, or men if the grounds be extensive, following them dressing the stocks in the way described; and in this manner the whole work can be made to go on at once without losing any time.

1980. If the stocks of the old trees which were cut down are not numerous upon the ground, as is more than likely to be the case if the trees were of any considerable age, there will not be nearly enough for a permanent crop upon the ground. If, for instance, they were 80 years old, there will not be more than from 60 to 70 trees to the acre. Now, to have a piece of forest-ground with that number of stocks upon it to the acre, would never pay the proprietor the common rent of his land; therefore, in order to take advantage of the ground forming the vacant spaces between the stocks, and to make the whole pay ultimately as any other plantation would do, the ground should be properly drained wherever found necessary, and a crop of young oak or other hardwood trees planted all over it wherever there is room. In this case, the young hardwoods which may be put in, together with the old stocks, may be made to stand, as nearly as possible, 15 feet apart. All the intermediate spaces between them should be filled up with larches, so as to make the trees over the whole plantation stand about 5 feet one from another—that is, taking the old stocks into account also.

By filling up the ground in this manner, the old stocks will ultimately become of more value than if they had been left in an exposed state; while, from their growing more rapidly than the young trees, they will produce shelter to the latter in their young state; so that, putting the whole together, a plantation of this kind grows more rapidly than one altogether planted with young trees.

1981. When the young shoots from the old stocks have been allowed to grow undisturbed for two years, they should then be carefully looked over, and all small ones removed, leaving the strongest, all round the circumference, not closer than 8 inches one from another. These, again, should be left for other two years, when a second and final thinning should be made, choosing the strongest and healthiest shoots to remain, and in no case leaving more than 6 shoots to stand as a permanent crop upon any individual stock, or fewer still if the health and strength of the parent require it.

1982. When the young shoots have received their second course of thinning, as has been pointed out, they should at the same time receive a judicious pruning, in the same manner as has already been recommended for the pruning of young trees. The larch, as they grow up, should be thinned away by degrees, in order to give room to the hardwoods as they advance, whether to relieve the shoots from the old stocks or the young trees; and in every respect this thinning of the larch should be done as has already been recommended for the management of hardwood plantations generally.

1983. As a mixed plantation of the description under notice grows up, the growths from the old stocks may be treated either as coppice or as timber, along with the planted trees, as may suit the object of the proprietor. Many proprietors cultivate coppice of this description along with trees in their plantations, with the view of making cover for pheasants, and for this it answers admirably. For such a purpose the coppice growths are kept low and of a spreading habit, by their being headed down to a certain height, while the planted trees are trained up as timber above them. In this case, however, the coppice growths are rendered of little economic value, while they, from the crowded state in which they are kept, impede the free current of air which is necessary for the healthy growth of the trees standing with them; therefore, where a profitable crop is the object, this plan of dealing with the coppice growths should not be adopted. In all cases where coppice growths are mixed with planted trees, and where it is desirable to make the most value out of the crop, the best way is to thin out the weaker portion of the shoots as they make progress, and to leave ultimately only the very best on each stock to come on as trees along with the planted ones. Where, however, it is an object to have a portion of the coppice growths left in a thick state to answer the purpose of cover, then, in that case, the least promising part of them may be left—one stock here and there with all its growths—

which will have the effect of producing enough of cover, while they will not to any important degree injure the health of the general crop.

1984. In training up a mixed coppice and timber plantation of the description under notice, very considerable attention is necessary to see that the coppice growths do not injure the young planted hardwoods, as, from the rapid growth of the former in the early stages of the crop, they are very apt to overtop the latter, which are of comparatively slow growth, till they become well established and of some age. This, then, requires careful attention in the forester till the trees are got well up; but in all other respects the crop may be dealt with in thinning as in the case of other hardwood plantations.

SECTION VIII.—MANAGEMENT OF OSIER PLANTATIONS.

1985. In most countries in Europe, the cultivation of the osier or willow is much attended to for the purpose of basket and crate making, and as hoops for various sorts of barrels and boxes; and in the United States of America, in Canada, and even in Australia and New Zealand, this sort of crop is now being cultivated to a considerable extent for the same purposes.

1986. In Great Britain alone there are, we should say, some seven or eight thousand acres of land under this class of crop—producing, on an average, say three tons (green willows) per acre annually; or in all, about twenty thousand tons annually: and this exclusive of large quantities imported from the Continent every year. This points out that the osier crop of Great Britain is of considerable importance in the economy of the country; and therefore we propose to give in this section a few remarks as to how it should be dealt with, in order to secure the greatest bulk of useful willows from a given extent of ground.

1987. Many are of opinion that osiers do not grow well unless they are planted on land of a damp character in the subsoil. This is a mistake, however, as although the willow prefers land of a cool-bottomed nature, it will not succeed satisfactorily on any description of lands having stagnant water in the subsoil. Nor does it succeed well on land of a very dry description, as on such its roots fail to lay hold of sufficient moisture to maintain its healthy development. The description of land we have found most suitable for the healthy and full development of the osier is that which may be termed a strong loam, rather inclined to the nature of clay than otherwise. Still, as land of this particular character cannot be had in all parts of the country where it is desirable to grow willows; that of the description of light loam will suit perfectly well, provided always it is deep, and resting on a cool bottom—such as is generally found in hollows, and on flat-lying parts.

1988. The land being selected on which to grow a crop of osiers, it should in all cases be thoroughly drained, in order to remove stagnant water from the subsoil; and this done, it should next be trenched to the depth of 30 inches. After being trenched, it should be well manured, and put under a crop of turnip or potatoes, in order that it may be well cleaned from all root weeds, and after such crop has been removed, it will be in a fit state for receiving the willow plants.

1989. There is a very great variety of sorts in the willow family—some noted for their fineness and toughness for basket-making, others for their quality of splitting for various purposes, and many for their strength of annual growth, which renders them most suitable for the making of crates and barrel hoops. Indeed, in each part of the country where osiers are grown, the cultivator has some particular variety he prefers to all others, whether that may be for basket-making, for crates, or for hoops, as the case may be; so that we need not here refer to any particular sort which we would recommend, but leave the cultivator to choose for himself, according to the object he has in view in rearing this sort of crop.

1990. Osier plants should always be reared from cuttings put out in a nursery one year previous to planting them into the sites where they are to grow permanently; as by doing this a year is gained in the strength of the plants, and therefore they are capable of producing a crop earlier than they would if the cuttings were planted on the land at once. The cuttings should be taken from the strongest of the one-year growths of the variety to be cultivated; and these may be planted in the nursery-lines 3 inches apart, and about 15 inches apart between the rows. The cuttings should be made about 12 inches long, and inserted each about two-thirds of its length into the ground; and in making them, every one should be smoothly rounded on the bottom end with a sharp knife, and cut with a long slope on the upper end. Planted in this way, the cuttings will throw out numerous strong fibrous roots the first season, and become strong in stem, and fit to be planted into their permanent places the spring after.

1991. Where the object is that of rearing a crop for basket-making, the willows may be planted 12 inches apart in the rows, and 24 inches between the lines. Where a stronger class of willows is wanted for crates and hoops, however, the plants should be put in about 18 inches apart in the rows, and about 30 inches distant between the rows.

1992. The willow-plants should at all times be kept clear from weeds by hoeing the land frequently, as occasion may require, during the summer months; as if this be not attended to in a particular manner, the yearly weight of the crop will not increase to the extent it is capable of doing under good management in respect to cleaning.

1993. In cutting off a crop of willows from the stocks, the operator should be careful to do so close to the part from which they have sprung, as if this should not be attended to, the stocks will rapidly enlarge, while the willows will become smaller accordingly. The best cultivators of willows generally make a point to cut off from time to time, as it may be found necessary, any over-growths on the stocks, so as to keep them all of a proper size, and in a healthy and good bearing condition.

1994. After the willows have been all removed for the season, the ground should be regularly dug between the lines; not deeply, however, but only in such a way as to kill any root-weeds growing on the land, and to improve the soil by exposure to the weather. And, in order to keep the land continually in such a condition as to insure its producing a heavy crop of willows for the market, attention should be paid to give it a good manuring of well-rotted dung once in every period of three years. Where any cultivator of this class of crop has a considerable extent of land under it, say some 30 acres, he should make it a point in his management to manure 10 acres of it annually, and in this way he would have the whole extent manured once in every three years. Indeed, in the same systematic way, any extent, less or more, may be dealt with in order to keep up the condition of the land for the growth of heavy crops.

1995. It is perhaps unnecessary to remark here that the willows, as they are cut from the stocks, are at once carried off the ground, assorted into three sizes, and tied into bundles of a certain number each, in which state they are sold at so much per 100. Some parties, however, sell by bulk—that is, in some parts of England, after the willows have been assorted into three sizes, each size is tied up into bundles of a certain circumference—generally 24 inches—at one foot from the lower ends, and are sold accordingly.

1996. When it is wished to prevent willows from drying and becoming brittle after they are cut from the stocks, they should have their lower ends inserted about one foot into the soil in the bundled state; or the bundles may have their lower ends immersed in a pool of water.

CHAPTER XVI.

THE STRIPPING AND DRYING OF BARK USED FOR TANNING.

1997. The stripping and drying of bark used for tanning is an important part of forest operations. If not thoroughly acquainted with the proper manner of performing this work, a forester may be the means of causing much loss to his employer through bad management. We will therefore devote the present section to describing the manner in which the stripping and harvesting of bark is performed.

1998. Although there are various kinds of bark suitable for tanning purposes, yet at the present time there are only three kinds of wood the bark of which is used for tanning purposes—namely, the oak, the larch, and the birch. Other barks have been used for the purpose, such as willow, mountain ash, Spanish chestnut, and even alder, but now that there is a large supply of oak bark imported into this country from the Continent, tanners do not use these, seeing they can get plenty of good oak bark at a moderate rate; and it is in consequence of this large supply from the Continent that the price of bark is now so low.

1999. It is our intention to describe in this section, as plainly as we can, the way in which the operations of stripping and drying are done; and in attending to this, we will take up in their order the three kinds of bark which we have mentioned, as being used for tanning purposes at the present time—namely, oak, larch, and birch. Of course, the operations in each case are almost alike; but still there are a few minor differences which it is necessary to refer to, in order that the stripping of each may be properly gone about. We begin with the stripping of the oak.

2000. *Oak.*—The best season for stripping the bark of the oak is when the young leaves are just beginning to expand from the bud. Generally speaking, it may be said that it will come off from the 1st of May to the end of June,—that is, taking this country as a whole; but a great deal depends upon the part of the country in which the work is performed, and also upon the earliness and lateness of the season. In the south of England, we have seen the barking operations commenced about the middle of April, and all over and everything completed by the middle of May; while again in the central and northern parts of Scotland, we have only commenced during the first week in May, and continued peeling until the beginning of July. In Ireland, as a general rule, oak-peeling may be performed from about the end of April to the middle of June.

2001. Some time before commencing the cutting and stripping, the forester should go through the plantation himself, and mark all the trees or coppice shoots that he intends should be taken away. This he should do in order that he may have plenty time to devote to the work of stripping when this is begun; because, if the plantation be extensive, and many hands employed, he will find enough to do without marking, when the people have begun to work. When many hands are to be employed, therefore, the forester should have all the trees marked previous to beginning to cut and strip, by which means he will be enabled to give his undivided attention to the conducting of the workpeople and their operations.

2002. The forester's next consideration will be as to the number of people he will have to employ, in order to have the work done within a given time; and this of course will depend upon his own views as to the time he will have on hand, and upon the extent of the work to be done. Our own plan for arriving at a proper conclusion in a case of this kind is as follows:—

Supposing it is an oak coppice that is to be operated upon, we first take three of the shoots or trees that are to be cut—say, of three different sizes, one of medium small size, one of middle size, and one of a medium large size. These we get stripped, including the branches upon them; and supposing the bark taken off the three weighs 39 lb., this gives 13 lb. as an average of the raw bark which may be expected from each tree to be cut. We next find the number of trees to be cut in all in the plantation, which ought to be known by the forester in the act of marking them. Supposing, then, that there are 7466 trees in all to be taken out, then, if we assume that the raw bark in drying loses about one-third of its weight, we have only about 8¼ lb., instead of 13 lb., as the weight of bark off each tree when dried; and multiplying 7466, the number of trees to be cut, by 8¼, the number of pounds of bark supposed to be taken from each tree, we have in all 61,594 lb., or fully 27 tons. From the above method of calculation, the forester may come very near the truth; and we generally come within 5 per cent of the truth by going to work in this way.

2003. Having ascertained that 27 tons of bark are likely to be taken from the plantation, the next point is to ascertain what number of people will be required to strip this in 27 days—to which we shall suppose that the forester is obliged to confine himself. We calculate that in order to strip one ton of bark in the day, including all the necessary operations pertaining thereto, the following people will be required:—

1 stout boy, stripping bottoms of stems, at 1s. 6d. per day, .	£0	1	6
1 man "laying in" these, at 3s. per day, ...	0	3	0
2 cutters, at 3s. per day, ...	0	6	0
2 pruners of trees, at 2s. 6d. per day, ...	0	5	0
3 lads pruning branches, at 1s. 6d. per day, . . .	0	4	6
2 boys carrying branches, at 1s. per day, . . .	0	2	0
1 man putting up stages, and attending to bark on them, at 2s. 6d. per day, ...	0	2	6
2 lads carrying bark to stages, at 1s. 6d. per day, . .	0	3	0
12 women or boys stripping, at 1s. 6d. per day, . .	0	18	0
	£2	5	6

The above may be considered a fair estimate of the number of hands, and the amount of expenses that will be required in order to strip one ton of oak bark in a day; but a great deal depends upon the size of the trees, upon the rate of wages in the district, and upon the aptitude of the people employed for the work.

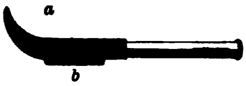
2004. We will now describe the duties of each of the people mentioned in the statement. Before the trees are cut down, a boy proceeds to strip off the bark, to the height of about 3 feet from the ground, right round the stem of each tree. This is done in order to prevent any waste of bark when the trees are being cut down; and the more readily to allow the cutters to apply their axes and saw. If it is intended that the stools of the trees to be cut are to bear coppice growths, the boy should have instructions to be very careful not to tear away any of the bark from the bottom of the tree, or from that part which is to be left as the stock after the tree is cut. If this is not attended to, the after-growths will be prevented from coming away; and in order to keep the stock uninjured, before the boy strips off the bark, he should first notch it through to the wood, all round the tree, with a light hatchet or handbill, about an inch or so above the surface of the ground, and also about 3 feet from the ground. He will next strip off the piece of bark with the barking-iron, in the same way as is done by the regular strippers—and should endeavour to take it off as whole as possible, in order to have the bark taken from the butt of the tree as a covering for the smaller bark on the ranges. In this way he should proceed from tree to tree before the cutters, stripping the lower part of each in the same manner.

A man will next follow with an axe, and "*lay in*" the outspreading parts of the bottoms of the stems of the trees, in order to prepare them for the saw. This should be done in a neat workmanlike manner, and in such a way as not to injure the stocks. We are assuming that the trees are all to be cut with the cross-cut saw, and we would certainly recommend this to be done in all cases where they are over 6 inches diameter at the bottom. We know that it is the custom in many parts of the country, and especially in England, to fell all trees with the axe, without any attention being paid to their size. We have had a good deal of experience in this matter, and can only say as the result, what we have already stated—namely, that all trees over 6 inches diameter should be cut down with the cross-cut saw. The chief advantages of this mode are briefly these—a saving of timber, neatness of appearance, and (after a little use) ease to the cutters.

2005. After the men have cut down the tree with the saw, other two men will follow with hatchets, and prune the branches from it; and in doing this they should be careful to cut off the branches in such a way as not to destroy the bark upon the main stem of the tree. The hatchets used for this work should be of a lighter description than those used by the cutters, and should be broader on the face.

2006. These men are followed by three strong lads with handbills, of the description shown in fig. 158, which are kept sharp both on the curved side *a*, and upon the straight face *b*. With these handbills they will clear the branches of all twigs, and cut them up into lengths of about 4 feet. All branches should be thus dealt with, down to those of about 1 inch in diameter at the small end. As they are pruned out and cut into lengths, they should be thrown regularly into heaps by themselves, so that they may be readily lifted and carried out of the wood by the next party. Of course, when large trees are cut down, many of the branches will be much too large to be cut in this manner by the lads. These can be left uncut, to be stripped by those who are taking the bark off the trunks of the trees in the usual way. It will be the duty of the forester to see that these lads do not pass over any of the branches, for this they are very apt to do, in order to keep up with the men in front; and by thus passing over some of the branches, a considerable quantity of bark may be lost.

Fig. 158.



2007. Other two boys will now take the branches that have been put in bundles, and carry them out to the nearest road in the wood, or other convenient place, in order to be stripped of their bark in the way in which we will describe farther on.

2008. After the trees have been cut down and pruned of their branches, a few of the workpeople should begin to strip them of their bark. The tools they will require are a mallet, a handbill, and a stripping-chisel or peeling-iron, and also, if the trees are small, a pair of forked stakes. The mallet is of the form represented in fig. 159, and the head should be made of good ash, 4 inches square at the flat part *a*, and about 6 inches deep to the sharp part at *b*; while the handle may be of pine, as it is more soft and cool for the hand than any other kind of wood, and should be 10 inches in length. These mallets are used for beating the bark upon the wood when it does not come off easily with the peeling-iron, and should only be used when the bark cannot be got off otherwise. The stripping-chisel or peeling-iron, which is shown in fig. 160, should be made of good iron, about 2½ inches on the face *a*, and the hose *b* may be about 4 inches in length, while the handle *c*, which is of wood, may be about 8 inches long. The one side of the iron should be a little curved, so as the more readily to go round the tree in taking off the bark.

Fig. 159.

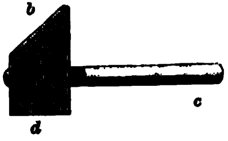
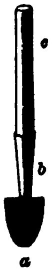


Fig. 160.



2009. In stripping the trees, it is usual for two people to go together to each tree, so as the more readily to assist each other in the work. As we have already said, if the trees are not too heavy, two forked stakes, the same as those used in putting up the stages, may be used, upon which to lay the end of the tree. These are placed in the ground in a slanting position opposite to each other, so that when the one end of the tree is lifted and put upon them, the one counteracts the power of the other, and thus the tree is kept steady upon them (see fig. 161). When the tree is thus lifted up, one of the peelers will take a handbill, of the description shown in fig. 158, and with it cut the bark right round the tree, into lengths of about 30 inches, beginning at the thick end. This being done from end to end of the tree, he will then, with the same implement, cut it longitudinally from the one end to the other—the bark being thus divided as shown in fig. 162, *b*, *b* representing the transverse cuts, and *a*, *a* the longitudinal cut. While the one peeler is thus engaged, the other will,

Fig. 161.

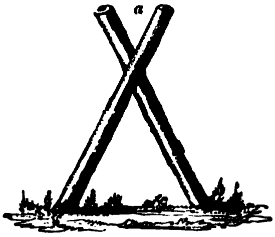


Fig. 162.

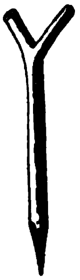
with the flat end of his mallet, beat the surface of the bark all round the tree. We do not mean it to be understood, however, that we advise beating with the mallet in all cases, but only in such as when, on trying to strip it off with the peeling-iron, it will not come off readily. In many parts of England, where the bark generally comes off the trees more readily, no beating is required at all; but usually in Scotland beating has to be practised to some extent. If the sap is well up in a tree, very little use will be found for the mallet; and it will be found that some trees are very readily stripped, while others close to them will be very difficult to strip. If beating has to be done, it should be done very softly and slightly, and on no account in a rough or heavy manner, for such a course would injure the colour of the bark when dried. The thinner the bark is, the less beating will be required, while thick strong bark is generally more difficult to come off. All this the people who are employed should be made aware of, as the more knowledge they have of the real nature of the work, the more profitable they are as workmen. As soon as the person has got the bark cut into lengths in the manner described, he will take his stripping-chisel and separate the bark from the wood, taking it off in pieces corresponding to the cuts he made with the bill; and as he takes off each piece, he will lay it aside in a heap with the other bark on the same tree. In this way the one will follow the other in close succession; and as soon as one tree is stripped of its bark, they will throw it off the forked stakes and proceed to another. In case the trees are too large and heavy to put upon the forked stakes, the people will first remove the bark from the uppermost side, and then get the tree turned over, when it can be removed altogether. It may be necessary to have a man in this case, to assist in turning the trees for all the people employed stripping them.

2010. At the same time that some of the people are employed at the trees themselves, the others will require to be stripping the branches, that were cut into lengths and carried out to the road. Each person should have a heap of the branches to strip by himself, as by this mode the workpeople generally do their work better and more quickly; and each should be provided with a flat smooth stone, from 8 to 10 inches square on the top, and about 6 inches deep. This arrangement made, the stripper will sit down upon the ground, keeping the bundle of small wood to be stripped upon his left side, and placing the stone upon the ground close to his left side also, with the smoothest side uppermost. He will next take a branch in his left hand, and lay it upon the stone, and with the flat part of the mallet he will beat the branch pretty firmly, till the bark opens from the wood, moving it along from one end to the other, and applying the mallet at the same time. After the branch has been thus beaten from end to end, the bark will come off easily with the hand, or if it should still stick to the wood, the chisel can be applied to take it off. In taking off the bark from the branches, it should be kept in as long lengths as possible, and laid in a bundle by itself beside the operator, who will in this manner strip all the branches in the heap beside him: and in the same way all the other strippers should be employed.

2011. As the bark is taken off the trees, and laid aside in heaps, it should be carried away by two lads, whose duty it will be to take it to the man who is putting up the stages, and attending to the drying of the bark on them. The bark from the branches can be carried to the drying-stages at any time when a sufficient quantity is taken off, say in the middle of the day, and in the evening before closing work.

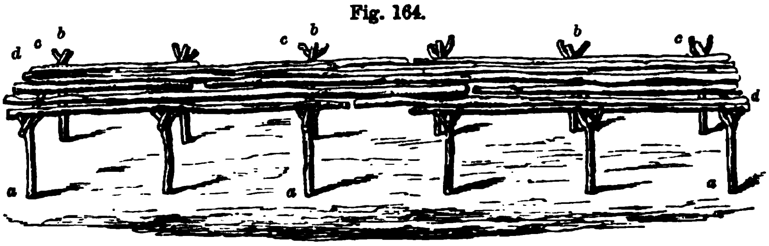
2012. The duty of putting up the stages, and of attending to the proper drying of the bark, should always be intrusted to a careful person, who has had some experience in this work before. In fact, this is the most important work of all in connection with the stripping and drying of any kind of bark, and in wet or showery weather it becomes a very difficult matter in many cases to get bark properly dried at all. The drying stages should be erected on some open and airy part of the plantation, or, if possible, upon the outside of it, where a free circulation of air will be continually had, and where the sunshine may be upon the stages at some part of the day, or as long during the day as possible. On this greatly depends the proper securing of the bark in good condition; and if it is not attended to, and the stages put up on a damp and sheltered situation, or under the drip of trees, the result will be that the bark will take a long time to dry, if it ever does become properly dry, and will cause almost double the expense in curing, that it would do if properly attended to. These stages are put up as follows:—From among the stripped sticks collect a number of forked stakes, of the form shown in fig. 163: these may be from 2½ to 3 inches in diameter, and about 3½ feet long. They should be driven into the ground in pairs right opposite to one another, and in two rows, as represented in fig. 164. A general view of the stage complete is here shown, *a a a* representing a front view of the forked stakes as they are driven into the ground, and *c c c* the tops of the row behind and opposite to them. The distance between the two rows may be about two feet. *b b b* represent pieces of the stripped sticks resting between each pair in their forked tops, and *d d* small trees of about 2 or 3 inches diameter, laid along on them for the purpose of supporting the bark. The distance between

Fig. 163.



these forked stakes, when driven into the ground, may be about 4 feet in the row; and in order that the rain may fall readily off the bark on the stage, the front row should be driven in with their tops about 4 inches lower than the back one. As soon as the bark is brought from the strippers by the lads, the man should place it upon the stages. In laying the bark upon the stage, great care should be taken to put it on in a regular manner, and lying all one way, like drawn straw. The whole bark—taking that stripped from the branches first—should be put on in a loose state, and by no means pressed together, but kept open, in order to allow the air to pass freely through it. The bark should never be laid on thicker than about 6 inches, and should always be placed with the inner or white side downwards; while on the top of the whole, as it is finished, the larger pieces, taken from the trunks of the trees, should be laid on outside uppermost, in order to keep rain from going down through it.

Fig. 164.



We have seen foresters cure their bark by placing one end of each piece upon the ground, and the other resting upon a single row of small trees supported on forked stakes. We cannot do otherwise than condemn this plan, as, however well it may dry in a very favourable season, it could not be well cured during even a moderately favourable one. When bark is placed with one end upon the ground, it absorbs moisture from it, thus causing the bark to be difficult to dry, and in damp weather often rotting it altogether.

2013. When the bark has stood for a few days upon the stages, it ought to be all gone over and turned. In the act of turning, all the freshest or greenest pieces should be kept to the top, mixing all the bark properly, but always taking care to keep the outside of the bark uppermost, and keeping as many large pieces on the top as possible. Some recommend the turning over of the bark, so that the side which formerly was up may be put down. This is a bad plan in our opinion, as, from the bark curling in at the edges when moderately dry, the water lodges in it as in a waterspout, and this invariably spoils the bark. It must also be remembered that when the bark is turned over in this way, the action of the sunshine on the inner sides of the pieces exposed decreases the weight of the material, and also extracts much of its most valuable tanning properties.

2014. If the weather continue fine, the bark may be dry enough in the course of eight or ten days from the time of stripping; but if it is dull and cloudy, two weeks may not be enough; and wet weather may cause much trouble in the drying. No specified time can be mentioned as to how long it may take to be in proper condition for stacking, as this altogether depends upon the state of the weather, and upon the situation of the drying stages. Whatever time it may take, it should be repeatedly turned, as we have recommended, in fine weather, and great care should be taken to see that the bark does not get mouldy or damped in any way. In wet weather it ought not to be touched, but as soon as a fine day comes, all hands should be put on to mix it as described. Its being properly dry may easily be known by all the natural sap being out of it, and by its being hard and breaking on trying to bend it. When properly cured it should be of a cream colour inside. When of a dark brown colour, it is plain that the bark has been injured by wet; and when this is the case, a lower price will be given for it. The more quickly it is cured, the better it is in its tanning qualities.

2015. When there is a large quantity of bark to be stripped in one district, and when there is the prospect of wet weather at the time of the operation, a good plan is to erect a temporary shed on an open and airy part of it, in which to dry the bark. This shed may be erected on stout posts fixed in the ground—say at 6 feet apart in the line of one of its sides—and it may be made of any height, length, or breadth, according to the quantity of bark to be cured. The sides should be left open, to admit all the air possible, but it should be covered on the top with deals, which should be overlapped and nailed on, so as to prevent rain from getting through, and wind from displacing them while the work is in operation, and the roof should be made to project some 12 inches over the line of the side-posts, in order to throw the rain well out from the sides. In this open-sided shed stages should be erected, 3, 4, or 5 tier in depth, on which the bark is laid to dry; and these stages may be made with rough wood to such an extent as may be found necessary for the curing of the quantity of bark on hand. In a shed of this kind, however, the bark dries slowly as compared with that dried outside; but there is this great advantage gained, that it is not exposed to wet. In order to dry it as quickly as possible, stages should be erected outside, all round the shed, on which the bark in the shed should be laid during good weather, and when there is the appearance of rain it can be removed to the stages inside, to keep it dry. In this way any quantity of bark may be cured, even although the weather should prove wet betimes, as it can always be exposed to the open air in favourable weather, and kept dry in the shed when that is unfavourable. Every advantage should, however, be taken of an opportunity of putting the bark outside, and on no account should it be kept in a shed unless the weather is such that it cannot well be cured otherwise. When drying in a shed, care should be taken that the bark does not get mouldy, as it is very apt to do if kept in a close confined place. Frequent turning is the only remedy against this, and all mouldy pieces should either be cleaned or thrown away altogether.

2016. When thoroughly dry, the bark can either be sold to the tanners at once, as it lies on the stages, or may be put in a stack, and kept thus until it can be sold to advantage. It is sometimes sold unchopped, but very often is delivered over to the purchaser in bags, chopped into small pieces. We shall suppose that the quantity of bark under our notice has to be built in a stack, and afterwards sent away in bags.

2017. The stack or rick should be built in an open airy place, where it will be exposed to drying winds, and where it will get plenty of sunshine. First form a good bottoming or foundation for the stack, by cutting any useless pieces of timber to the same length as the breadth of the stack required; and having these placed for the breadth of the stack, other pieces should be cut for the length, and placed across the first ones. In this way a foundation can be made, which will at once keep the stack off the ground, and allow a free current of air to pass through below it. The logs need not be very thick, but sufficient to keep the bark at the bottom of the stack about a foot from the ground; while any openings that may be in the framework thus made, can be filled up by placing a few of the stripped branches across them to prevent the bark falling through. In forming the rick, it ought not to be made wider than 7 or 8 feet at the bottom, but can be made of any length to suit circumstances. When making the bottom, it is a good plan to erect a few upright poles along both ends of the stack, for the purpose of guiding the builders, and keeping the stack steady. These should be put into the ground about 2 feet, and each should have a stay, in order to prevent them from giving way with the weight that will be upon them while the stack is being built. We need not add more as to the building of the stack, than to mention that, as the work goes on, the heart or middle should be well filled up with small bark, so that the middle of the rick shall always be higher than the sides, and thus cause the side pieces of bark to slope downwards towards the outside of the rick. The object of this is to prevent the rain-water from getting into the heart of the rick, which it would be certain to do, were the outside pieces of bark either level or sloped inwards. The height of the stack may be in proportion to the breadth, but should not be more than about 8 feet from the ground to the eave. The eaves should be made to project over the sides sufficiently to throw off the rain, and the top of the stack above the eaves should be made as steep as possible, and thatched with the largest flat pieces of bark that can be had. Other kinds of thatch are sometimes used, such as branches of trees, ferns, and broom; but we find that when the largest pieces of the bark are properly laid on, much in the same manner as the slates on a house-top, they make the best thatch, as they admit a free current of air, while they at the same time keep out the rain.

2018. If the forester has to deliver the bark to the tanner, it will require to be chipped and sent off in bags. In chipping bark, it is merely cut into small pieces of about 3 inches square, and these are filled into large bags for the purpose. Each bag as it is filled is weighed, so that in this way the bark is sold by the ton to the purchaser. There is now a machine for chopping bark, somewhat in the style of a chaff-cutter, which may be driven by a horse, but as we have not seen it at work, we do not profess to give an opinion as to its merits.

2019. *Larch.*—We need not enter into many details in regard to the stripping and drying of larch bark, but, as we have already said at the beginning of this section, merely mention any differences that are necessary in the work.

Larch is not now so frequently stripped of its bark as it used to be, as, from the large importations of foreign oak bark into the country, there is very little demand for bark of this kind. Of course it does not possess the tanning qualities in such a great degree as the oak, and for this reason it does not meet with such a sale, nor bring such a good price. Frequent objections have been raised by wood-merchants who buy larch timber to its being peeled at all, for the reason that if the wood is left for any length of time after being peeled it becomes cracked, especially so if the weather happens to be hot and dry at the time. We have often observed instances of this, where young larch poles that had been lying exposed to the influence of hot sunny weather had become split up in several places almost to the heart of the wood. This is sometimes a matter of some importance, and raises the question whether it is not better to leave larch without being stripped at all. However, we are of opinion that if properly looked after, and not allowed to lie too long after being peeled, larch can be stripped of its bark to great advantage. The principal advantage gained by removing the bark from the larch is, that a great saving is effected in the after carriage of the timber.

We have often had occasion to notice that larch trees, cut down and sold for pitwood, after being peeled lost more than a third of their weight; so that in this case—where the wood-merchant had a long carriage to pay—he saved a considerable amount in the carriage of the timber. The price obtained for the bark will generally pay all expenses of felling the trees, and of stripping and curing the bark; so that the saving in the carriage is all a gain to the purchaser of the timber. We are therefore of opinion that larch should be peeled, if a sale can be had for the bark at all, and especially where there is any considerable distance to convey the timber.

Larch may be stripped from about the middle or end of April to late in the season, and the time for peeling may be judged in the same way as the oak—namely, when the young leaves are expanding from the bud. Much depends on the season and on the locality, as to the time to begin. With regard to the actual operations of stripping the bark of the larch, they are in all respects similar to those practised in the stripping of the oak—with the exception that, in stripping larch bark, none is taken from the branches of the trees, but merely that from the stem. The mallet is seldom found necessary, as when the bark on the tree is cut into lengths in a similar way to what we have recommended in stripping the oak, it comes off easily with the stripping chisel. In stripping the larch, fewer hands will be required to strip one ton per day than we have already stated as being required for the oak. The following statement is our estimate as to cutting larchwood, and stripping and curing per ton of the bark:—

1 stout boy, stripping lower part of stems, at 1s. 6d. per day,	£0	1	6
1 man, laying in roots, at 3s. per day, . . .	0	3	0
2 cutters, at 3s. per day, ...	0	6	0
2 pruners of trees, at 2s. 6d. per day, . . .	0	5	0
1 man, putting up stages, &c., at 2s. 6d. per day, . .	0	2	6
2 lads, carrying bark to stages, at 1s. 6d. per day, . .	0	3	0
6 women or boys stripping, at 1s. 6d. per day, . .	0	9	0
	£1	10	0

2020. We would recommend that larch bark be dried upon stages in quite the same way as is done with the oak; still this may be more easily done by placing the lightest of the larch trees upon the ground, or upon forked stakes, and putting the bark on them. Larch bark usually dries in a shorter time than oak bark, and is much less liable to injury, although all due care must be exercised in the work, or quantities may become damaged if not properly attended to. We have seen it dried and put into the stack in four days after being stripped; but that was in a very favourable season.

The stack is put up in quite the same way as we have described for the building of an oak bark stack, and special attention should be paid that all the bark is perfectly dry before being put into it.

2021. Instead of being chipped into small pieces with an edged tool, this kind of bark is very often threshed with flails. In doing this, a tarpaulin or waterproof sheet is laid out on the ground, and on it the bark is placed, and the flails applied. The bark being dry and brittle, it easily breaks into pieces, and can be filled into bags as the work of threshing proceeds. The work can be done readily in this way, and generally at the rate of one ton per man per day.

2022. *Birch.*—As is the case with the larch, there is now comparatively little demand for birch bark. In some places, however, the bark of the birch is still used for tanning, although not nearly to such an extent as formerly.

Birch may be stripped nearly a month earlier than the oak; but, as we have already said in regard to both oak and larch, the best season to begin may easily be known from the young buds beginning to burst. No definite rule can be laid down for this, all depending on the weather and the part of the country where the stripping is to be performed.

In the stripping of birch bark the same process is gone through as with the oak. It is much more easily dried than the oak, and is generally put upon a few sticks on the ground to dry.

Unless it has to be sent a long distance to the tanyard, this bark is generally sent direct from the stages unchipped; but, if necessary, it can be stacked, and afterwards chipped and bagged in quite the same way as oak bark. As the bark is of little value, however, it will be found necessary to expend as little time and labour upon it as is consistent with its proper drying and harvesting.

2023. Having now described the manner in which the stripping and drying of the different kinds of native barks are performed, we will, in concluding this section, offer a few general remarks, in addition to what we have already stated in regard to each.

2024. The first opportunity of the season should be taken advantage of to begin the work of stripping, as it will be found that bark stripped late in the season is never so valuable as that done early. The work should be commenced as soon as the trees will strip; and if it should be found that some of them do not strip so freely as others, these can be left until later, when the plantation can be gone over again. Another advantage derived from an early start is, that when the stools are intended to bear coppice growths, these come up with far more vigour than they would otherwise do if the trees were cut later in the season.

2025. If wood be allowed to lie more than one day unstripped after being cut, it will not part with the bark so easily as when newly cut. The forester, therefore, should observe this, and be careful not to allow one party to fall behind another, so as to keep the wood lying for any time unstripped. Much of the quickness of getting through with the work will depend upon this. The more healthy any tree is, the more easily is the bark removed from it, and the earlier in the season will it be ready for stripping. An unhealthy tree never parts with its bark readily. Much of the success, therefore, in stripping wood will depend upon the healthy nature of the trees; and the unhealthiness of a tree may be known very easily by its being longer in coming into leaf than others of its own species which are in a healthy state.

2026. It often happens that there are quantities of moss, &c., on the trees that are to be stripped. In this case it will be necessary to appoint a person, whose duty it will be to scrape all moss off the trees immediately after they are cut down and pruned of their branches, and before they are stripped. The proper tool for this purpose is what is called a *scraper*, and this consists of a piece of iron about 6 inches broad in the face, which is semicircular, in order the more readily to fit the trunk of the tree. A handle of about 2 feet in length is fitted to this, and is fixed at right angles to the iron. By drawing the scraper backwards and forwards along the tree, the moss can be easily taken off. All moss should be removed from the trees before being stripped, as, if this is not done, the bark will retain the moisture for a considerable time, and be found difficult to dry properly.

2027. It should be particularly noticed that no more beating with the mallet is practised than is really necessary. Some peelers use the mallet far too much, and, in consequence, render the bark easily spoiled by the least wet weather, and also much disfigured in colour, and inferior in quality. A better price can always be obtained for bark that has been stripped without beating than for that which has received a severe application of the mallet. We therefore advise all who have the charge of bark-stripping operations to use the mallet as little as possible, and only when really necessary.

2028. In spreading the bark on the ranges, it should never be put on thickly, as if there is much piled up in a heap it will take a long time to dry. We have already recommended that it should never be put on thicker than 6 inches; but we may add that, if the season is damp, and the bark thick and fleshy, it should be laid on even thinner than that. If spread thinly on the stage, and well attended to in the way of frequent turning and mixing, we have little fear of it being speedily cured if the weather is at all favourable.

2029. It is the practice still in some parts of the country to strip the bark from oak-trees while they are standing. The chief reasons for performing the work in this manner are, that trees thus dealt with are generally in hedgerows, or in close proximity to a field of corn, which would be damaged if the trees were cut down and laid among the crop; or that the timber-merchant considers that the timber is of better quality when cut in autumn than it would be if cut at the time of stripping when the sap is rising. The work is performed by a man ascending a ladder, and, beginning at the top of the tree, he descends to the bottom, stripping off the bark with a barking-iron as he comes down. He also carries a small axe, with which he cuts off the branches as he descends, and these are stripped on the ground by others as they are cut. The branches and bark are taken away at the time, while the trees are left standing to be cut in the autumn or winter months. This practice is now dying out to a great extent, and giving way to the usual one of stripping the trees after being cut down.

2030. When a stack of bark is being built, or when it is being chipped, the forester should have provided a few strong waterproof covers, similar to those used for covering railway trucks. These should be placed over the stack and the chipped bark upon the appearance of rain, as if the broken stack or the chipped bark should get much rain, a great deal of trouble will be the result, and probably the loss of a quantity of the bark. A sufficiency of these covers should always be in the possession of every forester who has the charge of work of this kind.

2031. It is a question sometimes asked, whether bark-stripping should be performed by piece-work or by day-wages. We are of opinion that where there are ornamental plantations to be gone over and thinned, the work had better be done by day-wages—as, in this case, the forester can see that no harm is done to the standing trees, and have more time to attend to the work properly. If, however, the work is to be done in an outlying plantation, where ornament is not so much the object, the work may very properly be done by piece-work, or at so much per ton of the bark. Of course, if the work is done by contract, a competent person will have to attend, and see that no harm is done to the standing crop, and that all the different operations are properly attended to, and not carelessly performed. The work in this case may be done either at so much per tree or so much per ton of bark.

2032. The larger that trees are when stripped, the greater is the quantity of bark that can be taken from them in a given time, and the cheaper is it stripped per ton. We have got oak timber trees cut down and stripped of their bark at the rate of 28s. per ton for the bark produced from them; while, on the other hand, in cutting young coppice shoots, and stripping them of their bark, we have paid as high as 60s. for the work per ton of the bark produced, all when dried and ready for sale. Of course the cost will vary according to the rate of wages in the district, and the size of the trees that are stripped. Contract prices given of course vary in the same way; but from 30s. to 40s. per ton may be taken as the general rule. For chipping and bagging the bark we have paid from 6s. to 8s. per ton. These remarks of course refer to oak bark; but larch and birch can be stripped for about one-third less, and chipped and bagged for about the same proportion.

2033. The selling price of the different kinds of barks varies from year to year, according to the demand and to the season. Oak bark will generally bring from £4 to £7 per ton; but within the last few years it has fallen in price considerably. There is little demand for the other kinds, larch bringing from £2, 10s. to £4, while birch may sell about the same price per ton.

CHAPTER XVII.

SECTION I.—SUGGESTIONS AS TO THE MODE OF DISPOSING OF THINNINGS AS THEY ARE REMOVED FROM THE STANDING CROP.

2034. The trees felled as thinnings in a plantation, whether the latter be large or small, young or old, should never be allowed to lie where they fall, but should be at once carried out to the nearest roads, and arranged there according to their kinds and sizes, when they will be ready for sale, or otherwise, as may be found desirable. Our own mode of going to work in respect to the felling and carrying out of the thinnings from a plantation is this:—As the trees are felled by one set of men, we have another who follow them, and either carry or drag the trees to the nearest roads. The latter set may be boys, if the trees are small, but men are required for the work if they are large: they carry them on their shoulders, if able, or drag them out with horses, if of sizes too heavy for them to carry.

2035. If the work to be performed is to any large extent, it may very properly be done by contract, provided always that the forester is an intelligent and experienced man, and can see to its being properly executed, as by contract there is great danger of having it carelessly performed, and very often to the damage of a considerable portion of the standing crop. In order to obviate damage being done to the crop from carelessly felling the thinnings, we generally recommend that the work should be done by the proprietor's servants, under the superintendence of the forester; still, where there is a large extent to operate on, it is sometimes found desirable to have the whole done by contract, as by this means it is generally got performed twenty per cent cheaper than by day labour.

2036. In thinning plantations, the forester should mark every tree to be felled; the contractor for the felling should follow him with his men, and cut down and prune the trees, at a certain rate per 100, according to size, and according to agreement in reference to the trees of a certain plantation; and the contractor should in all cases be bound in a penalty not to injure any standing tree not marked to be felled.

Another contractor should follow the one who fells the trees, and drag them all out to the roads, also at a certain rate per 100; and he also should be subject to a penalty if he injure any standing tree. By this mode of doing the work by contract, it is accomplished at the cheapest possible rate within a given time; and from being all done under the eye of the forester, who of course is held responsible for its right performance, it ought to be very satisfactorily executed.

2037. We generally enter into a contract with a party for the sale of the thinnings of a plantation before we cut the trees, so that by this means we know perfectly what we are doing in all the departments of the work. This is easily obtained, as there are always timber merchants enough anxious to purchase wood of every description, especially when it can be had in large quantities.

2038. If the thinnings of a plantation are of small sizes, and generally under *propwood* dimensions, we dispose of them at a certain rate per 100 or per 1000 trees, according to bargain previously entered into. If they are of sizes for propwood—viz., not less than 3 inches diameter at the small end, 6 feet up from the bottoms—we sell either by the dozen trees, by the 100 trees, by the prop of 6 feet length, or by the 100 lineal feet, as may be agreed upon. If they are of sizes above propwood, but under timber—that is, 8 inches diameter at the small end—we sell them either by the tree, by the dozen trees, or by the 100 trees; and if they are of timber size, we sell them at a certain rate per foot cube, according to the quality and kind, and according to the locality the plantation is in. And in all cases we have the purchaser bound to remove the whole by a certain day, or, failing this, he is liable to a heavy penalty. By adopting this mode of procedure, we never are subject to have cut wood lying unsold in the plantations; while, at the same time, we are enabled to calculate our way in the different branches of the work most satisfactorily, which cannot be so well done when the trees are first cut and sold afterwards.

2039. Such a mode of procedure is not indeed so necessary for the proper management of the disposal of thinnings in woods situated in the neighbourhood of populous districts; as, in such, a public sale of them after being cut is generally found the best mode for realising the highest value for them. The case, however, is very different in parts of the country at considerable distances from a ready market, and it is for the benefit of foresters so situated that we have made the foregoing remarks, as we have frequently seen men who had the management of extensive woods in far inland parts seem to have great difficulty in getting their thinnings disposed of advantageously, and only because they did not attend to enter into proper arrangements beforehand. We have known proprietors who would not be at the expense of thinning their plantations, because, they said, the sale of the thinnings would not pay the labour. We put them on the mode of going to work which we have just described, and the result is, that now those very proprietors are realising considerable revenues from their thinnings, while previously they could make but very little indeed of them. We have no doubt, therefore, that the foregoing remarks will prove advantageous to such as have to deal with woods in parts of the country comparatively far distant from a ready market.

2040. In conclusion on this head, we may state that no proprietor whose woods are far distant from a market should thin his plantations without first entering into contract with respectable parties for the sale of his thinnings; as, if he do, he is likely to lose by the work. We do not, of course, here refer to the gain in respect to the effects of the thinnings upon the plantations themselves, but only to the thinnings as a saleable commodity. No sensible man so circumstanced should attempt this; as when timber merchants are called to give an offer for wood in the cut state, from the very fact of its being cut, and therefore in a perishable state, they will not offer its value if they can help it, but will offer far under it, in order to make the most they can by the transaction; but when men are asked to give offers for wood or trees growing, they see that the proprietor is not compelled to sell in the meantime unless he pleases, and they therefore are more disposed to deal fairly, from seeing that if they do not, another likely will.

SECTION II.—SUGGESTIONS IN REGARD TO HOW THE MATURITY OF TREES MAY BE KNOWN, AND AS TO HOW THE MATURED CROPS OF PLANTATIONS GENERALLY SHOULD BE DEALT WITH.

2041. A crop of trees, as well as of grain, should be disposed of by the proprietor as soon as it becomes matured, and before it deteriorate in value. We state this generally, however, and not as applicable to the crops of plantations exclusively reared for ornamental purposes, but to such as have been planted and reared for the sake of their timber, which may be said in regard to most woods not specially preserved for effect in the neighbourhood of home grounds.

2042. That a plantation of timber-trees should be disposed of to the best advantage after it has become matured is generally admitted and acted upon by landed proprietors, but very often without judgment, and therefore to their own loss. In explanation of this, we may only state that we have frequently seen the crops of healthy plantations, which were increasing annually in value, sold and cut down, because they had attained a certain age, and because from this they were considered matured; while, on the other hand, we have as frequently seen plantations left standing, although they had been deteriorating in value for many years, because it was considered they could not be matured, not having attained the usual age that the species in ordinary cases takes to arrive at maturity. At this stage of our remarks the questions arise, When do trees usually arrive at maturity? And, How is it to be known when they have arrived at this stage? We shall endeavour to answer these questions.

2043. No age can be given as that at which any kind of tree arrives at maturity, as all depends upon the condition of the soil in which they grow, and upon the nature of the treatment they may have received collectively. We have seen the ash, and other hard-wooded trees, quite matured when only about 70 years of age; while we have also seen them in a healthy progressive state at 120 years. In the former case, the trees grew upon a light soil, and stood in a crowded condition from neglect of thinning; in the latter, they grew upon a heavy loam, had been well attended to in the way of thinning, and from this their health and vigour had been maintained. We have seen the larch matured under 30 years of age, because it grew on a wet, and therefore uncongenial, condition of soil; while, on the other hand, we have seen it in a healthy and still growing state although upwards of 100 years of age; but in this case the trees grew on a sloping bank of good land, and had free space for the spread of their branches. With regard to the Scots pine, although all the land in Strathspey and Braemar may be said to be naturally well adapted to the healthy growth of this tree, still, even in those parts it is found matured at all stages betwixt 60 and 200 years, according as the crops have had space for healthy development. These facts, then, go to prove that maturity in any plantation depends partly upon the nature of the soil, but still more upon the management they may have been trained up under. In short, management in the training up of a plantation is everything in respect to its being matured early or otherwise, as well as in respect to its ultimate value; for, generally speaking, the longer that a plantation continues to grow, the more likely is it to become of great value—and the more judiciously it is thinned, the more surely will this result be brought about.

2044. From the foregoing remarks, then, it is to be inferred that the maturity of a crop of trees is not to be judged by the length of time they may have grown, and that the continuance of the healthy action and increase of bulk to a great age in trees depends upon the nature and condition of the soil in which they stand, and even more so upon whether they have been well managed in regard to thinning. Some other criterion than age must therefore be laid down for our guidance in regard to the maturity of the crop of a plantation, and this we have no difficulty in applying with an infallible degree of security.

2045. All trees, while in a healthy and growing condition, throw out shoots at the points of their branches, and lay on their stems a quantity of new woody matter every year successively, proportionate to the species and to the stage of their existence, as well as proportionate to the nature of the soil and situation on which they grow. Trees, generally speaking, make the strongest annual shoots while under 50 years of age; after this stage the growths gradually lessen in length, till maturity approaches, when they all but cease to lengthen; and it is from this condition of the annual shoots that the maturity of trees may be known.

2046. In examining a plantation, then, with the view of ascertaining whether its crop is still making progress sufficient to warrant its being kept growing, or so matured that its being cleared is necessary in order to realise the highest possible value for it, the first point is to examine the general progress the shoots have made for some six years previously, and if it is found that the average of the length does not exceed from 2 to 3 inches annually, it is a strong proof that the trees are matured, and that they cannot possibly increase in bulk to such an extent as to make good the interest on their present value. If, however, after an examination of this sort, it be found that the annual shoots have averaged from 4 to 6 inches in length, with proportionate strength, during the six previous years, it would be premature to fell the trees, as such a length of the growths is an indication that they are still making such an annual addition to their value as to justify their being kept growing for some years longer. Another point should be attended to in examining a crop of trees with the view of learning whether they are matured or not, and that is the state of the foliage. On all trees in a healthy condition, and making considerable progress in growth, the leaves are large—according to species—fresh, and plentifully distributed on the young shoots; while, on such as are matured, and therefore may be said to be comparatively unhealthy, they are small, not well developed, and thinly distributed. There is still another point worthy of remark on this subject. It is this: the leading or top shoot of the stem of a tree invariably makes considerable annual progress upwards, so long as the tree itself continues in a healthy and growing condition; but as soon as the tree begins to fail in vigour and become matured, the top shoot ceases to make progress, and from this the tree becomes gradually flat-topped, and of a broad-headed character. This last feature is more particularly observable in the pine family, and is to be accounted for from the fact that as the tree loses vigour, its vitality fails to send its sap sufficiently up to enable it to make wood on the highest part, and it is therefore confined chiefly to the formation of woody matter on the lower branches; so that the top and higher branches of a tree always indicate the state of the subject in regard to maturity before the lower parts do.

2047. From these characteristics of the state of trees as they present themselves, whether as healthly and growing, or as matured, we think any intelligent man may be able readily to distinguish trees in the one condition or in the other. We ought here to remark, however, that notwithstanding there is at all times a great loss sustained by the proprietor who cuts his timber-trees before they are matured, as in such a case the crop is adding to its value every year, still, on the other hand, there is as great a loss sustained by the one who does not cut it till it is over-matured, as in this case the timber is much inferior in quality from being over-ripe, and consequently the purchaser will take care to give him a price for it accordingly; so that the most satisfactory course for all parties concerned is to decide upon disposing of a crop of trees before it becomes so matured as to make the quality of the timber doubtful. It is perhaps not generally known or understood, that as soon as trees have arrived at the stage of maturity indicated by extremely short growths of young wood, and by a very spare clothing of foliage, their timber is in a state of slow decomposition—not, perhaps, observable to the inexperienced eye, although it is to one accustomed to examine it with a magnifying power. So that this advanced stage of the trees should never be allowed to present itself where sound timber is an object, and where the highest possible price for a crop of it is expected.

2048. A satisfactory examination having been made of a crop of trees, we shall suppose that it has been found that portions of it have been found matured, but not over-much so, here and there; that other portions are so matured as to be deteriorating in value; and that on several parts it is still making considerable progress. Now these features, in regard to a crop of trees, will be found in all plantations of any considerable extent, whatever the kind of tree may be, as in no enclosure do the trees all grow alike, and arrive at maturity at the same time—very much depending upon the nature of different portions of the soil, and upon the difference of the aspect, &c. &c. In such a case, therefore, we should at once conclude, that although a portion, even to the extent of nearly one-half the crop, were in such a state as to justify its being kept for a time, still, from the fact of the other half being partly quite matured, and partly over-matured, there is the probability of a much greater loss by allowing the matured trees to remain till the others were so, than could possibly be made up by the increase of their growth, so that no hesitation should be entertained to cut the whole. It may indeed be argued that it would be better in such a case to dispose of the matured portions, and to leave the growing portions to improve. This, at the first glance, seems indeed reasonable, and in the case of hedgerow and park trees would be sound practice; but in the case of trees forming a plantation collectively, the result would be the contrary of good management,—as, were the matured portions cleared, and the portions which were making progress left, the latter would be sure to become impaired in health and stunted immediately when they were exposed by the removal of the other trees from them; so that the best policy in all such cases is to decide at once on clearing the whole crop. We recommend this from our own experience in dealing with the clearing of such plantations, and we do so from a full conviction of this mode being the most profitable in the end.

SECTION III.—RULES AND REGULATIONS NECESSARY TO BE OBSERVED IN THE CUTTING DOWN AND SELLING OF TREES, WHETHER AS THINNINGS OR CLEARINGS OF OLD TIMBER.

2049. The cutting down and disposing of timber forming, as it were, the harvest of forest operations, and much of the value of that harvest depending upon the manner in which it is done, it is of very great importance that the principles upon which it ought to be conducted should be well understood.

2050. There are two ways of disposing of timber—viz., by PUBLIC AUCTION and by PRIVATE BARGAIN, both of which ways may be put into practice upon any given place, according to local circumstances, to profitable account; but, generally speaking, where there is a large quantity of timber to dispose of at once, and more especially when it is of a mixed character, the greatest amount of money will be realised by the proprietor when he disposes of it by public auction. At public sales there are in all cases people collected who are in quest of various sorts of wood, from the smallest size to the largest, consequently a competition takes place among them, which generally brings each lot to its value before being sold. As to the manner of conducting public and private sales of wood, we shall here give our own method of procedure, beginning first with the selling of wood by public auction.

2051. We shall presume, then, in the first place, that the timber to be disposed of consists of thinnings of various sizes, taken from plantations of several different ages, and of different kinds of wood; and also presuming that the work of cutting is to be LET by contract, the trees, of course, having been previously marked by an experienced forester. We beg it to be understood here, that we do not mean to say that the cutting of all trees should be let by contract, for where there is an experienced forester upon an estate of moderate size, it is not necessary to do so; but where there does not happen to be such, or where the woods are of such an extent as to justify this mode, we find it necessary to have the cutting of wood let; and in such cases we bind the contracting party to do the work in the manner and according to the rules laid down in the following form of specification.

2052. SPECIFICATION of Work to be done in the cutting down and preparing Timber for Public Sale, on the Estate of D——e, November 1880.

Article 1. The trees to be cut for public sale are marked with white paint, and will be pointed out to the contractor by A B, residing at the East Lodge, D——e.

Art. 2. All the trees marked in the park must be cut down with the cross-cut saw. In the young plantations the trees marked may be cut down with the axe, excepting those that are *at and above* 6 inches diameter at the ground, all which must also be cut down with the cross-cut saw.

Art. 3. Each tree, previous to being cut over with the saw, must be *laid in* with the axe to the level of the surface of the ground, and then cross-cut to that level.

Art. 4. Any damage done to the standing trees by the falling of the others, or otherwise, shall be charged against the contractor at the rate of double the market value of each tree injured; and any damage done to the trees taken down by the careless work of the people employed, shall also be charged against the contractor at a rate equal to the deterioration in value caused by such damage.

Art. 5. Each tree, as it is cut down, must be neatly pruned from all side branches, and the bole laid entire along the side of the road, in order for sale—no cross-cutting of the bole being allowed.

Art. 6. The side branches, as they are taken from the trees, must be arranged into lots in order for sale, to the satisfaction of the above named A B, or any person named by the proprietor.

Art. 7. All implements, as well as horses, &c., that may be required for the performing of the work, to be furnished by the contractor.

Art. 8. The oak-trees marked are not to be cut down till the usual time of peeling in the summer, nor under the present agreement.

Art. 9. All the trees marked, excepting the oak, to be cut down and arranged into lots for sale, in the manner as detailed above, for the sum of 3s. per pound sterling of the amount of roup-roll, and to be finished and in readiness for sale on or before the 26th day of December next.

Art. 10. All disputes or differences that may arise as to the due execution and fulfilment of the foregoing articles, shall be referred to the determination of Mr J. O., forester at M——h, whose decision thereon shall be final.

The above form requires to be signed by the contractor and witnesses in the usual manner.

2053. By going to work in the way above specified, we have had many plantations thinned and the wood prepared for sale, and that in a very efficient manner—of course always employing a person who could do the work well, and who had been accustomed to work of the same kind before.

The person having the oversight should see that each sort is arranged into separate lots by itself; and no individual lot should contain less timber than 25 cubic feet, in order that there may be a cartload for the purchaser; and each individual tree should be pruned out to the full length.

2054. We have often had occasion to observe at sales of timber, that where large trees had been cross-cut to a particular length for the sake of convenience in having them removed from the interior of the wood to the side of the nearest road, they never sold nearly so well as others of the same dimensions and quality which had been left entire. The reason is, that purchasers of timber, when they have it in long lengths, can always apply it to many more purposes than they can do short lengths; therefore this is a point that should be strictly attended to in the preparing of wood for sale, because the value of trees may be much deteriorated by injudicious shortening of their boles.

2055. All timber of good quality should be lotted separately from that of indifferent quality. Let good timber be sold in lots by itself, and inferior timber in the same manner; and if possible, whatever number of cut trees may be put into a lot, let them be nearly of an equal size. The great advantages arising from such a system of arranging the wood into equal sizes and qualities will appear evident when we say, that if a purchaser come to a sale of wood with the view of buying, say, one lot of good small ash for handle-wood, and found the kind he wished to purchase mixed up with other inferior trees in the same lot, he might of course buy the lot in which he saw a few trees suitable for his purpose, but he would reckon little upon the value of the inferior trees sold along with them, he having no immediate use for such; and the same may be said of any other sorts mixed up in a careless manner. But where each sort is arranged according to its particular use and quality, the full value of each may be readily got from different people who may have a use for the different sorts.

2056. When trees are laid together in the way of lotting out for sale, the bottoms and tops should all be laid one way, and that in a regular manner, so that the purchasers may see at a glance the size and quality of the wood they may wish to purchase.

2057. All lots of wood prepared for public sale should be carried out of the plantations, and put upon the sides of the nearest roads;

for the convenience of purchasers getting to them with their carts, which arrangement is always in favour of the wood bringing a high price.

2058. After the wood has been all lotted in the manner advised above, each lot should be numbered and entered to a corresponding number in a book made out for the purpose, at the same time stating the kind of wood that each lot consists of, with the number of trees in each, and the medium value of the same. In order to illustrate this sort of book, as used by us, we shall here give a statement from our own, as taken from sales of wood which we have made. Such a statement, we are aware, will prove interesting and useful, both to proprietors and young foresters who may wish to have information on the point.

2059. WOOD LOTTED AND NUMBERED FOR SALE AT B——, 15th November 1880.

Number on each Lot.	Number of trees in each Lot.	Kinds of Timber in each Lot.	Names of Purchasers.	Forester's Valuation.			Value as sold at Sale.		
				£	s.	d.	£	s.	d.
1	5	Oak	John Philip, Bonnyrig	0	15	0	0	14	0
2	3	Do.	Do.	0	18	0	0	16	0
3	3	Do.	Do.	1	0	0	1	4	0
4	6	Do.	Do.	1	0	0	0	17	0
5	2	Do.	Robert Grindlay, Roseberry	1	6	0	1	10	0
6	7	Ash	Do.	0	12	0	0	13	0
7	11	Elm	R. Coldwells, Gorebridge	0	13	0	0	13	6
8	1	Larch	John Philip	0	18	0	1	2	0
9	1	Ash	M. Galbraith, Edinburgh	1	1	0	1	4	0
10	1	Do.	Do.	2	10	0	3	0	0
11	0	Firewood	T. Dalgleish, Gilmerton	0	3	0	0	3	6
12	0	Do.	Do.	0	4	0	0	3	9
13	1	Elm	Thomas Johnson, Temple	1	8	0	1	15	0
14	1	Sycamore	John Philip	2	10	0	2	15	0
15	1	Do.	John Carrick, Glasgow	7	10	0	8	12	6
16	1	Larch	John Philip	2	15	0	3	0	0
17	1	Do.	Do.	3	15	0	4	5	0
18	1	Ash	M. Galbraith	8	15	0	12	0	0
19	1	Beech	A. Easton	2	0	0	1	15	0
20	8	Spruce fir	John Philip	1	4	0	1	0	0
21	7	Beech	R. Coldwells	0	10	0	0	6	0
				41	7	0	47	9	3

The foregoing statement, taken from our note-book, will at once point out how we are in the habit of arranging and conducting sales of wood made by public roup.

The first three columns of the statement given, with our own valuation, are all filled up previous to the day of sale; and upon the day of sale we follow the auctioneer, and fill up the other two columns which were left blank—that is, we then enter the purchasers' names opposite each lot, and the price given; and as the clerk of the sale keeps also an account of the same, our book forms a check upon him in case of any mistake occurring; and, besides, such a book kept by the forester becomes a guide both to himself and the proprietor, for the purpose of ascertaining if the wood sell at a fair price or not.

2060. Relative to public sales of wood, it yet remains for me to state how they should be advertised and made known to the public; and this should be always done two or three weeks previous to the day of sale, so that time may be given for its being properly made known. The following is the form of intimation which we made regarding the sale just referred to. Its insertion may prove useful here to other foresters who may have occasion to give intimation of the same kind for their wood sales:—

SALE OF WOOD.

There will be sold by Public Roup,

ON THE ESTATE OF B——Y,

Near A——,

On Friday, the 15th November next,

A large quantity of Timber, consisting of Sycamore, Ash, Larch, and Beech, of large dimensions; a considerable quantity of Oak adapted for trams, spokes, and other country purposes; Ash for handle-wood; Larch, Scots Pine, and Spruce Fir, fit for deals, roofing, railway-sleepers, &c.

The above will be exposed in lots to suit purchasers. The Sale will begin at C—— Bridge, near Woodside village, exactly at ten o'clock forenoon.

B——Y, *October* 27, 1880.

2061. In order that such an intimation may be made properly public, it should be inserted in two or more of the local newspapers, and printed forms put up along the public thoroughfares, and sent to people who are known to be in the habit of buying wood.

2062. We shall now suppose that all the wood intended for sale has been cut and arranged in the manner advised above, and that due intimation has been given relative to the same, particularly observing to make a fair statement of the kinds of wood to be sold. The next important point the forester will have to attend to is, the articles and conditions of sale. The following is the form by which we are in the habit of exposing wood to public sale:—

ARTICLES and CONDITIONS of SALE of WOOD on the Estates of B——Y, to be exposed for Sale on this 15th day of November 1880.

Art. 1. The wood to be put up in lots, and at such upset prices as the company may think fit, and sold to the highest bidder, who shall be bound to implement the following conditions:—

Art. 2. Each lot to be at the entire risk of the purchaser thereof as soon as called down by the auctioneer; but none of the lots to be interfered with until a settlement for the same be made to the satisfaction of the exposer, his agent, and judge of the roup.

Art. 3. The exposer reserves one bode on each lot for his own behoof, and also power to adjourn the sale if he shall see cause.

Art. 4. Any damage done to the plantations, gates, or fences, in the removal of the wood from the ground or otherwise, shall be paid for by the purchaser against whom such loss or damage can be qualified, the master being always accountable for his servant.

Art. 5. Purchasers shall be allowed six weeks from the day of sale to remove their purchases from the ground; and should any purchaser fail in having his purchases removed by the time above specified, he shall forfeit his offer of purchase, and be liable to the exposer in one-fifth part of his offer of purchase in name of penalty; and the exposer shall have it in his power to do with each lot or lots as he may think proper for his own benefit. The first offerer, notwithstanding, shall remain bound for the original price.

Art. 6. Purchasers, if required, shall pay to the clerk of sale one-fourth of the price of each lot as a deposit.

Art. 7. All sums at and below ten pounds sterling to be paid ready money; and for all sums above ten pounds, three months' credit will be allowed on bill and caution being granted to the satisfaction of the exposer, his agent, and judge of the roup. Purchasers paying ready money shall be allowed sixpence per pound on all sums above five pounds.

Art. 8. A person duly authorised to point out the lots and receive payment of the same shall be in attendance every lawful day between the hours of seven o'clock morning and five o'clock evening during the time before specified.

Art. 9. Purchasers to meet with the exposer's agent and judge of the roup on Wednesday the 20th next, between the hours of twelve and two o'clock, in the B——y estate office, to settle for their purchases. Those, however, wishing to settle immediately after the sale will be accommodated.

Art. 10. Purchasers to pay the bill stamps their respective sums may require.

Art. 11. T. D. is hereby appointed judge of the roup, with full power to settle all differences that may arise between the purchaser and exposer, or between the purchasers themselves; and his decision shall be binding, without the power of appeal to any court of law.

In witness whereof,

(Signed) ____________________

2063. What we have stated in the foregoing part of this section is only applicable, properly speaking, to the sale of wood on a comparatively small scale, and which has been cut; but it is frequently found desirable and necessary to expose wood in a growing or standing state, and that on a large scale also. In such a case, the business requires to be gone about very minutely and carefully in all its branches, as a heavy responsibility attaches itself to the forester if anything go wrong in the result—we mean in respect to money matters,—and from this it is necessary that he provide himself with every precaution against fraud. For the information of foresters generally, we shall here give a sketch of how we proceed with sales of timber, and also copies of our forms of bargain with our purchasers. Having determined upon selling the timber on a certain district, we advertise it after the following manner, in some six of the most influential newspapers, and that for three consecutive weeks before the day of sale:—

2064. SALE OF TIMBER

IN THE FOREST OF DALABA, NEAR S——A.

There will be exposed to sale by Public Roup, on Friday the 27th current,
Within the Court-House, S——a,
At Eleven o'clock forenoon,

20,000 Standing Trees of Larch and Scots Pine, fit for railway-sleepers, boards, &c.
The trees are divided into ten different lots of various sizes to suit purchasers.
J. T., forester on the district, will point out the lots previous to the day of sale; and further particulars may be learned on application to J. B., agent to Sir A——S——, at Dalaba.

Dalaba, *March* 4, 1880.

2065. Previous to issuing such an advertisement, however, we have the trees intended for sale all marked and numbered, keeping each lot separately, so that all the trees in each can be properly distinguished from those of the other. The way we do this is: we begin our marking upon one side of the district purposed to be cleared, and continue successively from side to side, till we have the number of trees marked we desire to embrace in the first lot; when we commence the second lot alongside of it, taking care to make the marks of the trees of the second lot upon the opposite sides of the trees from those of the first, and so on with all the other lots, keeping all the marks of any lot upon one side, and reversing them alternately for each lot.

2066. We mark every tree in each lot, and enter its value in a book, so that we are perfectly prepared on the day of sale to state the number of trees in each lot, and to know as the sale goes on whether we are offered full value for each as it is put up.

2067. Our mode of marking the trees is this: we begin with lot No. 1; a man with an axe takes a slice from the side of the tree we intend to number on, and he makes it deep enough to take the bark clean off, with a thin slice of the outer wood. This done, another man follows with a piece of *red keel*, and marks on that part of the tree from which the slice was taken, thus, $\frac{1}{1}$. The man with the axe proceeds to the second tree and removes a similar slice from it, when the man who follows him with the keel marks on it thus, $\frac{2}{1}$;—and on the third tree $\frac{3}{1}$,—and so on with all the trees in the lot. When they have finished the marking and numbering of the trees in the first lot, they proceed to the second, of course taking care to mark the trees of it on the opposite sides from those of the first, and making the marks thus—$\frac{1}{2}$, $\frac{2}{2}$, $\frac{3}{2}$; and so on with each lot as the numbers rise. The meaning of this mode of numbering is this: $\frac{1}{1}$ represents the first tree of the first lot, $\frac{2}{1}$ the second, $\frac{3}{1}$ the third,—and so on with all the trees of the first lot, so that the last tree of the first lot might be $\frac{2000}{1}$, which means the tree numbering 2000 of the first lot. So with the numbers on the other lots; $\frac{1}{2}$ means the first tree of the second lot, $\frac{2}{2}$ the second: and in the same way all the trees of each lot are successively numbered, each in the order of its lot, so that the intending purchasers can see at any time they examine the lots the number of trees in them. All this obviates trouble afterwards. Again, while the men are thus engaged in marking and numbering the trees, the forester follows them and notes down their contents and value respectively; so that by the mode here described, any quantity of trees may be easily marked, valued, and disposed of with a great degree of correctness, and in the most satisfactory manner.

2068. Having got the trees all marked, numbered, lotted, and in every respect prepared for sale in the way described, we next get our conditions of sale drawn up; and as these form a most important branch of the business of selling wood by public auction, we shall here, for the benefit of foresters, give a copy of the form we are in the habit of using for such sales. This form is as follows, always prepared and drawn out on stamped paper before the sale commences:—

2069. ARTICLES and CONDITIONS of Roup and Sale of Larch and Pine Timber in the Forest of Dalaba, the property of Sir A. S. To be exposed to sale by Public Roup, at the sight and instance of J. B., agent to the said Sir A. S., within the Court-House of S——a, this Twenty-seventh day of March Eighteen hundred and eighty, at Eleven o'clock forenoon.

Art. 1. The said timber will be exposed to sale by public roup in ten different lots or in one or more lots, and during such space of time as the judge of sale hereinafter named may determine, at a certain upset price per lot; and the person offering the said upset price, and in case of more offerers than one, the highest offerer, shall be preferred to the purchase.

Art. 2. In case several offers shall be made for any lot or lots so put up, every subsequent offer shall be at least one pound sterling more than the preceding offer when under fifty pounds, two pounds when above fifty pounds and under one hundred pounds, and five pounds when above one hundred pounds; and each offerer shall subscribe his offer, if required by the judge of sale, and become bound for the sum offered by him in terms and upon the conditions of these articles.

Art. 3. The person preferred to the purchase of any lot or lots shall have right thereto after paying or otherwise settling for the same in terms of these articles, and the purchase-money shall be paid to the said J. B., as exposer foresaid, in manner following: The purchaser shall pay down into the hands of the clerk of sale herein-after named one-third part of the purchase-money in part payment of each lot, within fourteen days from the date of sale, which third part shall bear legal interest thereafter till paid; and grant bills for the balance of price with security, to the satisfaction of the exposer and judge of this sale, payable in S——a, by equal instalments, at three and six months from the date of sale. Acceptors of bills to pay the stamps; and no part of the timber will, on any pretence whatever, be permitted to be interfered with or taken into possession by purchasers until paid in cash, or otherwise duly settled for agreeably to these articles; all within the said space of fourteen days from the date of sale.

Art. 4. For all cash payments in full, discount at the rate of five per cent per annum will be allowed if paid within the said space of fourteen days.

Art. 5. The timber shall be felled, manufactured, and removed at the sole expense of the purchaser before the thirtieth day of May Eighteen hundred and eighty-one; but in the event of any one purchaser buying the whole of the timber exposed for sale, such purchaser shall be allowed two years from the date of sale to clear and carry away his purchase from the forest—the proprietor, the said Sir A. S., his heirs and executors, always retaining and reserving to himself and his foresaids a right of lien or hypothec prior and preferable to all other parties whatever over the timber sold in the forest until the purchasers' bills or purchase-prices are duly paid; and any person failing to clear the forest of his purchases within the time prescribed, shall forfeit and lose whatever timber belonging to him may be found in the forest after the expiry of the time allowed for removal, and the same shall revert and return to the said Sir A. S., or his foresaids, to be used or disposed of by him or them at pleasure. Purchasers will be allowed to erect saw-pits, saw-mills, and other accommodation for manufacturing their timber, in such places as the surveyor shall allow.

Art. 6. Purchasers are hereby taken bound to keep at all times clear of obstructions the roads and accesses to and in the forest, and not to do any injury to any tree or trees reserved from sale within any lot, or to those on any other portion of the forest; and no purchaser shall be permitted, on any pretence whatever, without the written permission of the surveyor of the forest, to light fires within the forest except for steam-machinery; and in the event of the reserved trees being in the least damaged or destroyed by the purchasers or those in their employment, the purchaser shall be bound to take the whole of the trees so damaged at the rate of five shillings sterling per cubic foot, according to the forester's measurement.

Art. 7. The lots, after the sale, shall be at the sole risk of the respective purchasers thereof; but no lot shall be taken possession of by the purchaser without written authority under the hands of the surveyor of the forest; and any person presuming to interfere with the lots, directly or by means of any other person or persons, without such written authority, shall be considered a wilful trespasser, and prosecuted as law directs.

Art 8. The trees constituting each lot are carefully, and believed to be correctly, numbered and described, and the purchasers are to take the same as numbered and described in the roup-roll appended to these articles, without being entitled to any compensation or abatement from the price offered and accepted, by reason or on account of any deficiency or mistake, alleged or real, in number, quantity, quality, or description, it being understood that parties have satisfied themselves as to these considerations previous to the day of sale.

Art. 9. Any purchaser failing to pay the said third part of the value of his purchases, and to grant a bill of security as aforesaid therefor, shall, in the option of the judge of this sale, not only forfeit his interest in and right to the purchase, but shall be liable to the exposer in one-fifth part of the price offered by him, in name of liquidate damages, which shall in no event be modified; and it shall be optional to the exposer either to hold the said purchases himself, or to re-expose the same to sale, or to declare the same to belong to the immediately preceding offerer; and in case intimation of such failure shall be made to the immediately preceding offerer within the space of seven days next after the expiry of the fourteen days mentioned in article number third of these conditions, he shall be deemed and held to be the purchaser, and shall be obliged, within six days after such intimation, to make payment of one-third part, and grant security as aforesaid for the price offered by him, under the like penalty of forfeiture; and so forth, the whole course of offerers, until these articles and conditions are implemented and fulfilled.

Art. 10. In the event of there being no competition, or no one offering the upset price for any lot or lots put up to sale, power is hereby reserved to the judge of the sale to reduce the said upset price, and again to expose the said lot or lots to public roup, at such upset price, and under such alterations or modifications of these conditions as he may think fit.

Art. 11. The exposer reserves to himself one offer on each lot previous to being struck out by the auctioneer of the sale.

Art. 12. H. D., licensed auctioneer, residing in S——a, is hereby appointed auctioneer of this sale; J. C., residing at D——, near S——a, clerk thereto; and the said H. D. is appointed judge thereof, with power to adjourn the same from time to time in regard to part or the whole of the timber, and, with or without such adjournment, to reduce the upset price, to alter or modify these articles and conditions, and to determine all questions or disputes that may arise in connection with this sale, between the exposer and the offerers or purchasers, or amongst the offerers themselves relative to the premises in any manner of way; and the said Sir A. S., by the subscription of these presents on his behalf, and the offerers by subscribing their offers on the roup-roll, are hereby taken bound respectively to fulfil the articles and conditions to each other under the penalty of two hundred pounds sterling, to be paid by the party failing to the party performing or willing to perform the same, over and above performance; and both parties consent to the registration hereof, and of the roup-roll or minute of roup, decerniture of the judge, and minute or minutes of enactment, in the Books of Council and Session, or others competent, therein to remain for preservation; and if necessary, that letters of horning on six days' charge, and all execution needful, may pass on a decree to be interponed hereto in common form, and thereto constitute

their procurators, &c. In witness whereof, these presents consisting of this and the two preceding pages of stamped paper, written by J. B., clerk to A. B., Writer in S——a, are subscribed by the said J. B. on behalf of the said Sir A. S., at S——a, the twenty-seventh day of March Eighteen hundred and eighty years, before these witnesses, D. G., clerk to the said A. B., and Robert Smith, clerk to the said J. B.

(Signed) J. B.,
For Sir A. S.

D. G., *Witness.*
R. S., *Witness.*

2070. In drawing out such a document, it must be kept specially in view to have this done on a sheet of stamped paper of sufficient value to carry the amount of the sale, as, if this should not be attended to, any legal prosecution afterwards could not be maintained. Of course the different conditions herein set forth can always be modified to suit the views of parties, and to suit the nature of the timber to be disposed of. Besides such articles and conditions of sale as the foregoing, previous to the proposed sale it will be necessary to have prepared and appended another document, which is referred to in the articles and conditions, and is called the Roup-Roll. This is merely an abstract account of the several lots, and the result of them after the sale. The following is a copy of the form of roup-roll we use, and attach to our conditions of sale, and this must be attached and in readiness, along with the conditions, before the sale commences.

2071. **Roup-Roll of Pine and Larch Timber, in the Forest of Dalaba, sold within the Court-House, S——a, 27th March 1880.**

No. of Lots.	Description of Trees.	Number of Trees in each Lot.	Names and Residences of Purchasers.	How settled.	Price.	Sums paid.
1	Scots pine	2000	Colin Archibald, Aberdeen, *Eight hundred pounds* (Signed) C. Archibald.	One-third paid, and remainder settled by bill.	£800 0 0	£266 13 4
2	...	1500	P. Grant, Grantown, *Six hundred pounds.* (Signed) P. Grant.	do.	600 0 0	200 0 0
3	...	1000	J. Robertson, Grantown, *Four hundred pounds.* (Signed) J. Robertson.	do.	400 0 0	133 6 8
4	...	3200	John Yule, Newburgh, *One thousand four hundred pounds.* (Signed) J. Yule.	do.	1400 0 0	466 13 4
5	...	4300	R. Urquhart, Forres. *One thousand six hundred pounds.* (Signed) R. Urquhart.	do.	1600 0 0	533 6 8
6	...	800	J. M'Pherson, Dunkeld, *Three hundred pounds.* (Signed) J. M'Pherson.	do.	300 0 0	100 0 0
7	...	2500	R. Nicholson, Newcastle. *One thousand five hundred pounds.* (Signed) R. Nicholson.	do.	1500 0 0	500 0 0
8	...	1200	J. M'Kenzie, Perth, *Four hundred pounds.* (Signed) J. M'Kenzie.	do.	400 0 0	133 6 8
9	Larch.	1500	A. Oswald, Perth. *Nine hundred pounds.* (Signed) A. Oswald.	do.	900 0 0	300 0 0
10	...	2000	John Yule, Newburgh, *One thousand five hundred pounds.* (Signed) J. Yule.	do.	1500 0 0	500 0 0
		20,000	Total amount of Sale, ...		£9400 0 0	
			Paid on day of Sale, ...			£3133 6 8

2072. In conducting such an extensive sale as is represented by the foregoing copy of roup-roll, it is necessary to have a clerk constantly engaged while the sale goes on in taking down the names and residences of every one who gives an offer for any lot, as, if this is not attended to, the exposer cannot fall back upon the bidders for the respective lots—as provided for in the articles and conditions—in the case of the parties to whom they were sold failing to implement the conditions of payment. It is not, indeed, often that parties fail to make payment according to the conditions stipulated; but as it does sometimes happen, and we have experienced it ourselves, it is necessary to be prepared for the worst; and by taking a note of every offer given for each lot at the sale, the exposer can always fall back upon them to make good their offers, if required.

2073. In an extensive transaction of this kind, the exposer should cause every purchaser of a lot to subscribe it as it is knocked down to him; this prevents misunderstandings afterwards, and lays a strong hold on the buyer to fulfil his bargain; and what is perhaps better for the proprietor of the timber, it gives him a legal hold upon the purchaser that he could not otherwise have.

2074. In the same manner as shown in the preceding section, any sorts of trees may be given intimation of and sold. Oak and other coppice woods are generally sold by the acre, or they may be sold in lots to any certain or convenient extent, mentioning about the number of acres in each lot, which should be all valued previous to the day of sale: such sales of coppice may be made in the month of February or March.

2075. Having said thus much relative to public sales of wood, it yet remains for us to refer to the conducting of wood sales by private bargain.

In the selling of timber by private bargain, it is generally done at a certain rate per cubic foot, according to kind and quality: or it may be done at so much per tree, or so much for a certain number of trees; and in this case the trees are of course valued by the forester previous to making his bargain with the purchaser. In some cases where we have had a quantity of timber to dispose of, and which was to sell by private bargain, we have taken private offers for the same from different parties who were inclined to have it, and sold to the person who gave the highest price for the whole.

In a transaction of the kind, however, especially when it is to a considerable extent, and involving some risk, it is necessary to have a proper form of agreement drawn out on stamped paper, and signed by the parties, as without such an agreement, even although the price should be paid in advance, misunderstandings are apt to arise, which very often lead to lawsuits. Where, however, proper written conditions of agreement are attended to in such matters, both parties get on pleasantly, from having such a document to refer to. As an example of an agreement for wood sold by private bargain, we shall give a copy of one made with a party who bought 20,000 trees from a property we had to do with. Such a document we have no doubt will be highly useful in enabling foresters to adopt such a mode of procedure in their dealing with parties privately for sales of wood. The following is the copy of agreement referred to:—

2076. CONTRACT of SALE betwixt A. B., for Sir J. R., and J. R. & W. M., Timber Merchants, E———d.

It is contracted, agreed, and ended, betwixt A. B., residing at R———e, near G———n, wood-manager to, and for behoof of, Sir J. R., and duly authorised in the premises, on the one part, and J. R. & W. M., timber merchants at E———d, on the other part, in manner following:—That is to say, the said parties, considering that the said J. R. & W. M. have offered to the said A. B., acting for the said Sir J. R., the proprietor, for twenty thousand Scots pine trees, standing in the forest of R———n, partly on R———n Braes, and partly on the west side of Tor Hill, all as already marked off and pointed out, the total sum of Two thousand nine hundred and eighty pounds and fourteen shillings sterling, which offer the said A. B., acting foresaid, has accepted upon the terms and subject to the conditions hereinafter set forth; and as it is necessary to enter into a contract of sale containing the usual and necessary clauses, therefore the said parties have contracted and agreed as follows:—

Article 1. The said twenty thousand trees shall be, by the district forester, made into lots of various sizes, and for the first lot, containing seven thousand nine hundred and twenty-eight trees, the said J. R. & W. M. bind and oblige themselves to pay at the rate of five shillings and sixpence for each tree; for the second lot, containing two thousand three hundred and forty-four trees, at the rate of five shillings per tree; for the third lot, containing eight thousand and thirty trees, at the rate of sixpence per tree; and for the fourth and last lot, containing one thousand six hundred and ninety-eight trees, at the rate of twopence per tree; the aggregate price of which several lots amounts to the foresaid sum of two thousand nine hundred and eighty pounds and fourteen shillings sterling.

Art. 2. The said J. R. & W. M. bind and oblige themselves forthwith, and before they have right in any way to interfere with any part of said twenty thousand trees, to pay to the said A. B., for behoof foresaid, the sum of nine hundred and ninety-three pounds eleven shillings and fourpence sterling, being one-third part of the purchase-price of said timber; and grant bill with security to the satisfaction of the said A. B. for remaining two-thirds, payable in G———n, by two equal instalments, at six and twelve months from the date of these presents.

Art. 3. It is contracted and agreed that the purchasers shall have, from the date of these presents, three years to remove their purchase from the lands of the forest; and they bind and oblige themselves, and their heirs and successors, to remove the said timber by such roads and accesses as shall be pointed out by the said A. B. or the district forester; and further, the said

J. R. & W. M. bind and oblige themselves, during said period of three years, to keep clear of all obstructions the roads and accesses to and from and in the forest, to be used by them; and to pay one-half the sum required for making new roads for their exclusive use, and a like proportion of the sum necessary for repairing roads made to be used by them.

Art. 4. It is contracted and agreed that the said J. R. & W. M. shall have a site for a saw-mill on the farm of R———n, where pointed out; and they bind and oblige themselves and foresaids to remove from said mill and mill-site at the first term of Whitsunday after the expiration of said period of three years, and that without any summons of removing or process whatever.

Art. 5. The said J. R. & W. M. bind and oblige themselves and their foresaids to pay for any damage done by them or their servants to timber, standing or lying, in or near the forest, not forming part of their purchase, double the value of such timber, and the same shall, notwithstanding such payment, remain the property of the original owner; and the said J. R. & W. M. further bind and oblige themselves not to interfere with, or break down, any part of the forest enclosures in the course of their operations, without the sanction of the district forester, and then, upon such conditions as shall be stipulated by him.

Art. 6. It is contracted and agreed that the said J. R. & W. M. shall be responsible for damage done by fires kindled within the forest, by themselves or their servants, without the sanction of the forester.

Art. 7. It is specially contracted and agreed that the said Sir J. R. and his foresaids shall, during the currency of the bill to be granted for two-thirds of the purchase hereby made, as before provided, have a right of lien or hypothec over any part of said purchase on or near to the lands of the forest, prior and preferable to all other creditors of the purchasers; and it is further agreed that, should the purchasers fail in the observance of any of the conditions stipulated by this contract, it shall be in the option of the said A. B. or Sir J. R.'s wood-manager for the time, upon such failure, either to permit this contract to remain obligatory, or to declare it at an end, and forthwith to eject and remove the purchasers and their foresaids, and all others acting in their name, from the lands of the forest, and from said mill-site, and to enter upon possession of the same, and that without any declarator or process whatever; and it is hereby declared that the purchasers shall be held to have failed in their said obligations, in the event that they shall not duly pay the instalments of the price falling due under the bill to be granted as before provided; and,

Lastly. Both parties, the said A. B. for Sir J.. R., and the said J. R. & W. M., bind and oblige themselves to implement this contract to each other under a penalty of Two hundred pounds sterling, to be paid by the party failing to perform to the party performing, or willing to perform, over and above performance; and both parties consent to the registration hereof in the books of Council and Session, or other Judge's books competent, therein to remain for preservation, and that all necessary execution, on six days' charge, may pass upon a decree to be interponed hereto in form as effeirs; and to that effect they constitute

their procurators, &c. In witness whereof, these presents, written on this and the three preceding pages by A. B., Writer in G————, are subscribed as follows—viz., by the said A. B., at G——n, the eighteenth day of March

Eighteen hundred and eighty years, before these witnesses, the said A. B., the writer hereof, and H. B., his clerk, and by the said J. R. & W. M., at E——d, the twenty-third day of March, year last mentioned, before these witnesses, A. H., banker, W——l, and A. M., accountant there.

	(Signed)	A. B.
A. B., *Witness.*	(„)	J. R.
H. B., *Witness.*	(„)	W. M.
A. H., *Witness.*		
A. M., *Witness.*		

With an agreement after the foregoing form, containing all necessary clauses and conditions, any sale may be made by private contract on equally as sure grounds as if the sale had been made under the conditions provided for a public sale. Having given this form at full length, we think it unnecessary to comment upon it, as it speaks for itself, and as it can be altered to suit the use of any description of sale, whether large or small, of whatever kind of trees, or under any peculiarity of circumstances.

2077. The foregoing statements are applicable only to wood as it is sold in the round or rough state; but the selling of wood by private bargain, when cut up into various scantlings at saw-mills, is very different, and sometimes a matter of considerable difficulty to young foresters. Therefore, for their assistance, we shall here give a few statements, showing how they may be able to calculate the fair value of timber, of any scantling, as they may have occasion to sell it from saw-mills under their charge.

2078. We shall suppose that a forester is in the habit of getting 1s. 2d. per cubic foot for his larch timber, as sold lying in the plantations in the round state, and that he has charge of a saw-mill, at which he wishes to cut up his larch for sale to various sorts of scantlings as may be required. We shall further suppose that he wishes to learn at what rate he should sell the cubic foot of sawn timber, so as to have at least the same profit to the proprietor off the cut timber that he is in the habit of realising from the round. In order to illustrate this point in as clear a manner as possible, we shall suppose that the forester has lying cut in one of the plantations under his charge—say one mile distant from the saw-mill—150 cubic feet of larch timber, which he values at 1s. 2d. per cubic foot, or at £8, 15s. for the lot, being the sum he could realise for it in the forest, independent of any further trouble. The question now is: At what rate per cubic foot should this larch be sold, after being carted from the woods and cut up at the mill, so as to realise the original price and cover all necessary expenses? The following statement will form an answer to the question:—

To 2 horses and carts, drawing 150 feet of larch from the woods, 1 mile distant from the saw-mill, at 6s. per day for each horse,	£0	12	0
To 1 man assisting in loading carts, at 2s. 6d., ...	0	2	6
To 4 men in saw-mill 1 day, cutting up the same into scantling, 6 × 2 inches, at 3s. per day each, ...	0	12	0
To keeping up machinery of mill, files for saws, oil, &c. &c. &c.,	0	18	0
	£2	4	6

Here, now, we have the outlay necessary for converting the 150 feet of rough wood into scantling at the saw-mill—namely, £2, 4s. 6d.—being 4d. additional upon the cubic foot nearly; therefore, in order to realise the original sum of 1s. 2d. per foot for the proprietor, the forester will require to lay on 4d. extra on each foot of the sawn wood, making it 1s. 6d. per foot to the buyer of the wood from the mill.

2079. In order to illustrate this case still further, we shall suppose that a house-carpenter comes to the forester, and inquires at what rate *per lineal foot* he could supply the above larch scantling—namely, 6 inches by 2 inches—for roofing purposes, and to be laid down at a distance of 4 miles from the saw-mill. Here, again, the forester will require to consider how much extra per cubic foot it will take to lay the wood down at a distance of 4 miles from the saw-mill. We reckon that 30 feet of sawn timber is a fair load for a horse; and, at 4 miles distant, a horse will take two loads in a day—that is, a horse will draw from the mill 60 feet in one day to a distance of 4 miles. Therefore, calculating 6s. a-day for a man with a horse, and 3d. for toll, we have 60 feet of timber laid down for 6s. 3d., making 1¼d. extra on the foot—that is to say, the forester could lay the scantling down, at 4 miles distance from the saw-mill, at 1s. 7¼d. per cubic foot, and still have the 1s. 2d. clear for the proprietor. The forester having now, we shall suppose, ascertained the price per cubic foot at which he could lay down the sawn timber to the carpenter, his next point of inquiry is, and which the carpenter desires to be made aware of, at what rate per lineal foot he could give the scantling. Our method of calculation in a case of this nature is as follows:—

	In. In.	
The square of the end of the scantling, .	6 × 2 = 12)	144
Number of lineal feet required to make 1 foot cube, . .		12

Here we have the square of the scantling, which is 12, exactly 12 times out of 144; thus showing that, of a scantling 6 × 2 inches, 12 feet in length are required to make 1 cubic foot of timber; therefore these 12 lineal feet can be sold at 1s. 7¼d., or at 1⅝d. nearly per lineal foot, which is the answer required.

2080. As every forester should be well acquainted with the sort of calculations now under notice, we will here give another statement of a different scantling from the last.

We shall suppose that a forester gets an order from a party for a quantity of paling rails, say 4 × 1 inch, to be Scots pine. We will say that the forester sells his Scots pine, of the size adapted for paling, at 8d. per cubic foot in the rough state; and that he reckons that, to bring the wood into the mill and saw it up, will cost him 4d. extra per foot, as in the former case. Here, then, the price of the sawn wood will be 1s. per cubic foot; and the forester wishes to ascertain at what rate he can sell the paling rails per yard of 3 feet lineal measure. In order to ascertain this he has to calculate thus:—

In. In.
The square of the end of the scantling, . 4 × 1 = 4) 144
Number of lineal feet required to make 1 foot cube, . . 36

That is, it requires 36 feet in length of a scantling 4 × 1 to make a cubic foot of wood; and in 36 feet in length there are of course 12 yards; therefore, if 12 yards in length cost 1s., the forester is enabled to sell the paling rails at 1d. per yard, and still have 8d. per foot cube for the proprietor as the value of his timber.

2081. Knowing that calculations of this nature are extremely useful to all denominations of foresters, we shall, before concluding this section, give yet another example, showing how to calculate the value of deals per square foot, according to the rule formerly given. Suppose that a forester is requested to supply deals of 1 inch in thickness to a party from his saw-mill—say from old Scots pine timber—and that the deals must be at least 12 inches broad. In this case we shall suppose that the forester values his Scots pine at 1s. 2d. per foot lying in the woods in the rough state; then he must add to this the expense of mill-work and cartage, as in the former cases, at 4d. per foot; and say that he can supply the sawn wood at 1s. 6d. per foot cube, his next point of inquiry will be, at what rate he should sell this wood per square foot when sawn into deals of 1 inch thickness.

It was said that the deals were to be 12 inches in breadth, therefore the calculation will again be thus:—

In. In.
Square of thickness and breadth, . . 12 × 1 = 12) 144
Number of lineal feet required to make 1 foot cube, . . 12

Here, again, we find that it takes 12 superficial feet of boards to make 1 cubic foot of timber; which, again, is reckoned in value at 1s. 6d.; therefore the forester can supply the boards 1 inch thick at 1½d. per square foot. Having given the above statements, it would be superfluous to give any more upon a matter so very simple, as the rule is the same in all cases, whatever be the size of the scantling, and whatever may be the price of the wood per cubic foot.

2082. In conclusion, we may here add, that unless a forester be well acquainted with the above rule for calculating the value of cut wood, he cannot be able to sell it by private bargain to parties who may be inquiring after it. Where wood is cut up at saw-mills, people will come inquiring after scantlings of every size and kind of timber; and if the man who has the charge be not able to give a clear and definite answer about the value of wood to builders and others who may wish to deal with him, they will at once consider him a person of inferior capabilities; and in such a case many will be ready to take the advantage, and try to secure a bargain for themselves at the cost of the forester's character and the proprietor's purse.

CHAPTER XVIII.

SECTION I.—OUR FOREST-TREES ARE SUBJECT TO VARIOUS DISEASES.

2083. In the natural forest there may be said to be no disease among trees, as there each kind selects the soil that is conducive to its healthy growth, and in consequence all are alike healthy, and all grow up to natural maturity. In the natural forest, it is true, we here and there find young subjects of a stunted and unpromising description; but these grow up and live only for a short time, being the produce of seed that has sprung up on spots unfavourable to the full development of the species, and therefore they are soon overtopped by other species that spring up, which species, finding the soil adapted to them, quickly grow up and obliterate in a very short time all traces of the plants that had sprung up with them on the same piece of ground. We have in many cases had opportunities of observing this state of things in regard to trees in the American woods—that is, there can be, properly speaking, no diseases among trees there as we find them in our artificial plantations; and for the reason that, where any plants do spring up on land unfit for their healthy development, they grow so slowly that other kinds to which the soil is congenial, and which spring up among them, ere long overtop them and crush them out of sight; and thus the ground is, in all cases, ultimately occupied by trees suited to grow healthily upon it. No doubt we find in the natural forest trees coming to maturity and dying at various ages—many of them at very early ages—but this is not occasioned by disease, but by being smothered to death by their neighbours—the stronger in all cases overtopping and crushing down the weaker, till only the strongest are left to occupy the ground.

2084. The case is very different in our artificial forests and plantations, however; as in these, generally speaking, the plants are not indigenous to the land, are all of one age, and all at nearly equal distances apart from each other; so that from this they grow all nearly alike—slowly if the soil be in a condition unsuitable for them, and rapidly if it be favourable. If the plant here is suited to the soil, no disease is found; but if, on the contrary, the plants have not been well chosen for the soil, disease is found in the subjects in various forms and degrees, according to the proportion of unsuitableness in the condition of the soil to the plants.

2085. The foregoing remarks are applicable only in so far as disease in our trees is caused by unsuitableness of soil; but in this country, where we grow a very great number of subjects of different families, collected from different countries, there are also diseases arising from unsuitableness of situation and local climate, and these also take various forms, according to the degree of fitness or unfitness of the situation to the subjects affected. For example, take any tree that is found to grow well with us on sheltered valleys, and place it on an exposed site—the soil being the same in both cases—and it will be found that some derangement has taken place in the action of its functions, less or more, according to the degree of exposure, and therefore showing different symptoms, according to the peculiarities of the case; and, on the other hand, take any tree that naturally grows on high-lying sites, with pure dry air, and place it in a low-lying, sheltered, and humid situation—the character of the soil being the same in both cases—and it also will be found to have undergone some change in its constitution, and at some stage—probably at an early one—to show peculiar symptoms of disease. These remarks are, we think, sufficient to prove that all diseases in our forest-trees are found to arise from unsuitableness of situation and condition of soil, and that they take various forms, according to the degree of unsuitableness to which they are subjected. From this it is therefore to be inferred that wherever disease is found to exist in trees, it is to be traced to the one or the other of these causes, or it may be to both combined; and that the only cure is to place the subjects in such conditions of soil and situation as are known to be most favourable to the healthy development of the species.

SECTION II.—EXTERNAL SYMPTOMS OF DISEASE IN TREES, AND GENERAL CAUSES OF THE SAME.

2086. Trees, like animals, are subject to various diseases, which, if not arrested by removing their causes, often either make them die suddenly, or retard their growth to such an extent that prematurity is speedily brought on. Disease in trees, like disease in animals, in all cases throws out external symptoms by which it can be detected; but in order to this the experienced eye is required. To the inexperienced, trees will often appear healthy, while in reality they may be the reverse. We have, in many instances where we have been called upon by proprietors to inspect their plantations, found them entertaining high expectations as to the future welfare of some favourite plantation, while we found it our duty to give them reports quite opposite to what they expected. We refer to this here, because we are well aware that plantations are often looked upon as being in a good state, while the contrary is the truth. Disease in trees, as in animals, is confined to no particular stage of their existence; from the sapling in the nursery-row to the full-grown tree in the forest, it may often be detected, causing premature decay in the subjects. Although this is a fact too often observable, and, we may say, too little attended to, by professional men, yet, generally, trees are not apt to die either suddenly or prematurely when planted and existing under favourable circumstances as to soil and situation; and any failures which do take place can in most cases be traced to the true cause—that being either in the nature of the soil, climate, or management of the cultivator. Moreover, trees, like animals, although they should grow up healthily and arrive at the most perfect state of maturity the soil and situation upon which they grow admit of, will begin to experience the gradual approaches of natural decay; the life-principle of the trees will cease to act; and if not cut down before this stage arrives—which will, of course, be different, according to the species and nature of the soil—they will, in the case of some soft-wooded trees at least, soon moulder into their original earth.

2087. The healthy development of trees, like that of animals, depends much upon the wholesome state of their food, and, at the same time, upon the want or excess of it—that is, if a plant, like an animal, receive too little food, its development will be irregular and stunted, and if too much of any particular ingredient, that excess must prove the parent of disease in its system, and of disease more fatal than the want of it altogether would have caused.

2088. Every tree in full health, and considerably under the age of maturity, produces annually an elongation of all its branches, and an increase in the diameter of its body proportionate to its species; and the external bark, more especially in the hardwood sorts, should be clean and smooth. The amount of the increase of growth in any given time is not, however, always a true criterion of its health. For example, we have often had occasion to remark, in cutting down trees, that one which was rotten in the heart had made, up to the time of its being cut down, greater annual layers of young wood upon the stem than another beside it which was perfectly sound and healthy. This will no doubt appear at first sight doubtful to the inexperienced, but it is, notwithstanding, the truth; and we merely refer to the circumstance in order to show that the increase in the annual layers of young wood upon the stem does not always indicate the true state of the tree. Even in such a case as this, however, there are always outward symptoms by which an experienced eye can pretty readily detect the inward rottenness: there is an indescribable something stamped upon the general bearing of the subject which betrays the hidden disease. Again, relative to this point, a tree upon an exposed situation may be making but small annual layers of young wood as compared with one of the same species in a sheltered part, and at the same time they may be both equally healthy; therefore, in judging aright of the health of any tree or plantation, the circumstances above mentioned must be taken into account. We said that the external bark of trees in full health should be clean and smooth; but relative to this also, caution is necessary ere we judge by the assertion simply as it stands. A tree may be in good health and yet have the external bark somewhat coated with lichen, and rough; for smooth and clean bark is more an attendant upon young trees in rapid growth than an indication of sound health, properly speaking. We could point out trees having a clean and smooth bark considerably damaged by inward disease; while, on the other hand, trees may be shown with a rough, mossy, and furrowed bark, perfectly healthy and free from all disease; thus showing that smooth bark is not altogether to be relied on in passing judgment on the state of a tree, but that other attendant circumstances must be taken into account. These statements may, to the inexperienced forester, appear contradictory, but such is often the case; and we merely advert to them to show that any single mark of either disease or health is not in all cases to be relied on; for the apparent marks of both health and disease may exist on the same patient at the same time; and it may even require a close investigation from the most experienced of either foresters or vegetable physiologists before deciding as to its state. Having thus premised, it is not our intention here to enter into details regarding, or even to refer to, all the diseases to which trees are liable in our climate. This would of itself be matter for more than one volume of ordinary dimensions; it is, in fact, more a subject of vegetable physiology than one belonging to such a work as the present, which is, strictly speaking, a plain practical work on the rearing of forest-trees. It is, however, necessary that we should here advert a little to such diseases in forest-trees as are generally the offspring of bad management in the forester; and, accordingly, we shall point out the external symptoms of such diseases, the general causes of the same, the means of cure most likely to succeed where the trees are infected. and those of prevention where no disease may yet have appeared.

2089. The principal diseases likely to be brought on forest-trees by bad management are—1st, *Bark-bound;* 2d, *Moss or lichen upon the bark;* 3d, *Stag-horn tops;* 4th, *Scale;* 5th, *Premature bearing of seed;* 6th, *Dropsy;* 7th, *Ulcers;* 8th, *Wounds;* 9th, *Stunted growth of the young wood.*

2090. Any of the above-mentioned diseases may, to a considerable extent, be brought on trees by a mismanagement in their cultivation; and with regard to the first mentioned—namely *bark-bound*—it may very frequently be found to exist on hardwood trees in any soil or situation where they may have been injudiciously managed, either in the way of planting, pruning, or thinning. The external appearance of a tree in the state termed *bark-bound* may be thus stated: outer bark hard and compressed, and of a dry coriaceous texture; the stem of the tree, as also the larger branches, with young shoots springing out immediately from the bark at irregular intervals. When the disease is not of long standing upon a tree, if a longitudinal incision with a knife be made in the summer in the outer bark, it will immediately contract upon each side of the incision, leaving the cut much wider than the instrument could make in the case of a healthy tree; but if the disease be of long standing, this contraction of the bark will not take place, at once indicating that the wood of the tree and its bark adhere so closely together, that the sap cannot flow between them. Another symptom of this disease in a tree is, that the proper lateral and top branches make small and weak annual shoots; and each year, as the disease becomes more confirmed, the annual shoots become the more weakly. The cause of this disease, as its name expresses, is the bark being *bound* or girded about the wood of the tree, thereby preventing the free flow of the proper sap from the roots to the leaves, and also arresting the descent of proper woody matter between the wood and the bark. In this case, if the cause of the disease be not removed in proper time, the vital fluids become gradually checked, till at last the passages become entirely closed, and, as the natural consequence, the tree dies.

2091. We have already stated that "bark-bound" may be caused by injudicious planting, pruning, or thinning. As caused by injudicious planting, we have often occasion to witness it when any tree is planted in an unsuitable soil, and on a situation too high and exposed for its healthy development. For example, the spruce fir or the ash, in all cases where they are found planted in a light soil and upon an exposed and high part of the country, more particularly if growing upon the outside of a plantation, will be found of a short bushy habit, having their bark hard, and adhering to the wood, and scarcely showing any symptoms of vitality till far on in summer. In this state the trees are bark-bound, which disease is caused by the vital fluids being not strong enough to resist the cold and drying influences of the atmosphere; and in such circumstances the trees seldom assume anything like a respectable size. As to recovery in a case of this nature, we have never been able to see how that could be effected: we may as well say that a geranium, which may have been planted in an improper soil and on an exposed site, should be made to grow as well as one in a sheltered part. Of course all that is required is a change of soil and protection; but this would be impracticable with regard to a spruce fir or an ash under such circumstances. The fault rests with the planter; for, in fact, the trees so situated, according to their nature, are not in a state of soil and air adapted for their healthy growth: premature death must therefore be the result. The same results will follow in the case of any other kind of trees that may be planted upon a soil too poor, and on a situation too exposed for their health; and the disease, under those circumstances, is incurable—at once showing the evil and ruinous effects of planting trees in a situation not adapted for them.

2092. As caused by injudicious pruning, we have often witnessed this disease to a fearful extent, even where formerly the trees were in excellent state. Trees that may receive a severe pruning of their larger branches, more particularly if they are in a plantation which has been severely thinned at the same time, are almost certain to become bark-bound, however healthy they may have been before that operation was performed upon them. In this case the disease is caused by the severe denuding of the trees of their branches, the subjects being rendered weakly from want of leaves to elaborate their sap, and from the atmosphere being thereby cooled down suddenly about them; and the only rational remedy under such circumstances, is to allow the trees to regain their former shelter as nearly as possible. Trees under such circumstances, if under 30 years of age, are very likely gradually to recover, although they will never afterwards attain such valuable size as they would have done had they received no check from such disease; but if the trees are much above that age, they are not likely ever to recover, at least so far as to become valuable as timber.

2093. The results are much the same with regard to the disease, as it is often caused by injudicious thinning. When the atmosphere of the plantation is suddenly cooled down by a severe thinning, the sap is retarded in its ascent, and expended in keeping up the life-principle of the tree. The consequence is, that little woody matter is returned from the leaves, the bark gradually becomes dry, and the trees, should they recover, do so slowly, and never afterwards reach the value they would have attained had they been properly dealt with. Trees, although injured by severe pruning and thinning, as above stated, may, notwithstanding, be in a great measure recovered, and that by two methods—namely, by removing the diseased outer bark from the tree, or by softening the bark by means of any moist substance.

2094. In attempting the recovery of bark-bound trees by removing the outer bark, it is only necessary to have this chipped or scraped off by means of any moderately sharp iron instrument. If the trees to be operated upon are young, with a thin smooth bark, care must be taken to scrape only; but if the trees be pretty old, with a rough thick coat of outer bark, it must be chipped off. We have frequently seen an old hedge-knife used for this purpose, and that with great effect. In removing the outer bark, the operator must be careful not to injure the soft inner bark next the proper wood. We consider the month of April to be the best season of the year for performing this operation on trees. The foregoing method is frequently practised for the purpose of recovering trees diseased in the bark, but it is not nearly so effectual in bringing about a thorough cure as that of softening the diseased outer bark by means of some moist substance applied to it. Therefore, to those who may find it necessary to apply a remedy for recovering bark-bound trees, we would recommend them to proceed thus: Have a quantity of good moss gathered from the woods, or from an old grass field, of the same description as is commonly used by nurserymen for packing, and have it well incorporated with nearly an equal bulk of fresh cow-dung, making the mixture form a complete plaster. With this cover the bark all over the stem of the tree affected, as also part of the larger branches, to the thickness of about one inch; and in order to keep this plaster on, have the whole wound round with ordinary hay or straw ropes. If this be applied in the autumn, and allowed to remain till the May following, the bark will be completely softened and in a pliable state; but in order that it may not receive any sudden check from the influence of the weather after the plaster has been removed, it is advisable to have the whole wound round again with fresh hay-ropes, these being allowed to remain till they become wasted and naturally fall off, when a complete cure will be found effected. In dry weather it will be an advantage to syringe with water the ropes upon the trees, which will tend to keep the bark in a healthy soft state.

2095. With regard to the second-mentioned external symptom of unhealthiness in trees—namely, *moss or lichen upon the bark*—this may be found to exist upon trees in a variety of circumstances, soils, and situations, and is not always a symptom of unhealthiness. In any district of country where much rain falls, almost all trees will, to a certain extent, be found infested with lichen; and, notwithstanding, the trees may grow vigorously and be found in good state, as we have frequently witnessed. Trees existing in a damp humid atmosphere, where they have not a free circulation of air about them, are generally much overgrown with lichen upon their stems. In this case a diseased state of the trees cannot be said to be the cause of the lichen growing upon them; but such trees, existing in a state of air favourable to the development of the lichen-seeds upon their bark, may be ultimately much injured by the plants excluding light and air from the bark; and in this case, draining of the soil, so as to carry off all superfluous moisture, thinning the trees judiciously, so as to admit a free current of air, and removing the lichen from the bark, will generally completely restore them. But if those requisites of health have been too long neglected, it will be impossible to effect a cure. Trees existing in a high and exposed situation, more especially if the subsoil upon which they are growing is cold and damp, are almost always much infested by both moss and lichen. In such circumstances this is caused by the languid state of the juices of the trees, and their not being, as it were, sufficiently strong to resist a degree of decomposition in the outer bark. In a case of this nature, the only remedy is to have the subsoil made wholesome for the roots of the trees by draining, and to preserve shelter as much as possible, by not over-thinning or unduly exposing the trees.

2096. Again, any plantation which may have stood for a considerable time in a confined state for want of thinning, may, after receiving a severe and injudicious thinning, become unhealthy in the outer bark; and, as a certain natural consequence, the trees will be much overgrown with lichen. In this case, the cause of this growth is the sudden exposure of the trees rendering the bark diseased. We have frequently seen this take place where bad management prevailed; and after the trees had grown more closely together, so as to produce shelter throughout, the lichen disappeared. We thus see that the appearance of lichen upon the bark of trees is not always a symptom of decided disease in them, but may be occasioned by a temporary derangement in the natural functions of the outer bark; and if observed in time, like any other disease, may be arrested by removing the cause before it has had time to become decidedly fixed in the constitution of the trees affected.

2097. What has been said relative to the appearance of moss and lichen upon trees, is principally applicable to the hardwood sorts. As to lichen affecting the pine and fir tribes, we shall speak of that shortly. In the meantime, we would remark here that hardwood trees generally are more easily cured of any disease than pines or firs are,—the reason appearing to be, that their juices are more pliant than those of the others. The juices of the pines and firs are of a thick consistency, and any sudden check to the life-principle of those trees at once stagnates their juices and renders them unfit for circulation; whereas, in the case of the hardwood sorts—such as the oak, ash, &c.—the juices are thin and of a watery consistency; and although those trees may receive an injury in their constitution, their juices will continue to flow to a certain extent, and thus keep up the life of the tree; and, as the cause of disease gradually subsides, they will regain their former strength.

2098. Almost all trees growing in high districts, unless the soil be favourable, are less or more infested by lichen, which is occasioned, we think, by the want of a full flow of sap in the trees to keep the bark in a soft moist state. The bark of all such trees, when they have arrived at any considerable size and age, is found dry and hard, and, as it were, in a half-decomposed state—thus becoming a favourable receptable for the growth of the seeds of lichens; yet the trees, under these circumstances, may be healthy enough in their constitution. It must, however, be admitted that, under such circumstances, trees cannot grow vigorously, or attain the valuable size they would do under more favourable ones. In all such cases, therefore, it would be a very great improvement to scrape off this outer diseased bark, and thus remove the lichen and allow the stems of the trees to expand more freely by the influence of light and heat penetrating more readily through the bark. On the other hand, almost all trees growing upon a sheltered district of country—unless, indeed, where the soil may be unfavourable to their growth—are generally found clean and free from either moss or lichen; the reason of which appears to us, that the trees growing in favourable circumstances of soil and situation have a vigorous constitution, with a full flow of sap, which keeps all their parts in a healthy state, so that no opportunity is afforded to the seeds of such plants harbouring on them.

2099. From what has been said above, it will appear plain that, where moss or lichen exists upon trees, it is in general a symptom of something wrong, although not always a symptom of decided disease, but possibly occasioned by some temporary derangement in the functions of the bark. The only way to prevent this appearance is to keep the soil dry, to admit a free circulation of air, and not to give any sudden check by over-thinning.

2100. With regard, however, to lichen growing upon the bark of the larch, fir, and pine tribes, and where it is retained upon them without intermission the whole year, the case is very different. In these it is a certain indication of a degree of decomposition in the heartwood of the trees affected by it. In all our surveying of plantations in Ireland, England, and Scotland during the last thirty years, we have seldom been deceived in pronouncing, relative to larch, pine, and fir trees, whether they were in a healthy or unhealthy state, and that by the appearance of the lichen and moss upon their bark alone. In doing this, however, there is an indescribable something which we are guided by in our own mind, and which we could not here explain for the guidance of others; it is, in short, a mere tact of observation combined with experience, which is inexpressible upon paper. We may say thus far, that wherever the lichen is found to extend about two-thirds up the entire height of the stem of a tree, and is also spreading out upon the branches, and not falling off during the summer, decomposition in the heartwood is evidently going on. Such trees should at once be cut down, as the longer they stand they will become of the less value. There is also something to be founded on from the appearance and kinds of the lichens and mosses at different stages of disease; but this can only be explained by close observation upon the subjects.

2101. The *third* external symptom of disease in trees is *stag-horn top*. This symptom is one easily distinguished from all others by the top and upper branches of the tree affected becoming dead and quite bare of all leaves and young twigs, having the appearance of stags' horns. This disease may be occasioned by dampness in the subsoil in the case of some sorts of trees, and by the want of sufficient moisture in that of others. It is generally preceded by one, and sometimes by both of the symptoms already mentioned, and is, we may say, in all cases, irrecoverable, except by draining and pollarding, by which means the tree affected may indeed be made to lengthen out its existence, but not to regain its former healthy constitution. Willows and poplars, which luxuriate in a soil rather damp than otherwise, generally become stag-horn-topped when grown in a soil too dry for their healthy development, and that as soon as they have arrived at such maturity upon the soil upon which they may be growing, as its nature is capable of bringing them to. It at once indicates their premature state; and the wisest thing is to cut them down, seeing the soil is not adapted for their growth. Elm, oak, ash, sycamore, &c., generally become stag-horn-topped when the soil in which they may be growing is too damp for maintaining them in a healthy state; and in this case, if the disease be observed in time, draining the soil, and cutting off the parts affected, may produce a cure: but if the subject is old, and the disease has made considerable progress, it is seldom that recovery can be secured,—at least so fully that the tree can ever become a valuable and healthy one.

2102. The *fourth* external symptom of disease in trees is *scale*, which is a small white insect found clinging to the bark of some species. In forest-trees it is most frequently found upon the ash while in a young state. This insect, like lichen, is indicative of a constringent state of the bark, and may be often found upon the bark of young ash-trees which have received an injudicious and too sudden thinning. We have also often seen it to a very great degree on ash-trees growing upon a light gravelly soil, which is not congenial to their healthy growth. This latter case at once points out that the constitution of the trees affected under such circumstances is impaired, and that they will not succeed to anything worth, whatever means may be used for their recovery. Where it is evident that trees with scale upon them have been injured by a too severe thinning, the case is very different. These may be recovered by scraping off the outer bark with the scale, and allowing the trees in future to become more close among one another, so as to produce shelter sufficient for their health, as was recommended for bark-bound trees. The scale is easily distinguished by the appearance of the insect upon the surface of the bark. It presents itself as very numerous small white spots, like those on the bark of the birch; and if the observer take a stone and draw it roughly along the tree, he will kill many of the insects, and see their blood give a red tinge to the bark.

2103. The *fifth* external symptom of disease in trees is *premature bearing of seed.* Trees, in a healthy rapid-growing state, are seldom found to produce seed till they have arrived at a considerable age and size. Generally speaking, any forest-tree bearing much seed under 40 years of age is not likely, ultimately, to arrive at a valuable size. Any tree, however healthy a state it may be in, may be made to bear seed, simply by mutilating its roots, or by pulling it over; thus at once showing us that, before a young tree produces seed, it must be brought into some degree of an unhealthy state, either naturally or artificially. Being aware of this, it will at once be evident that, when we find a young tree producing profusion of seed, there can be no doubt but that it is in a state of premature decay; therefore, in all such cases we may be at once assured that such trees will not become valuable as timber. In short, when found under those circumstances, disease must have been going on for a considerable length of time, and we are not aware of any successful means that could be applied for their recovery. The premature bearing of much seed in the larch, we have in all cases found to be a sure index of heart-rot in the trees; and even in the cases of pines of any kind, the bearing of much seed in their young state at once points out a weakness in their constitution, and tells, to the observing eye, that the trees are not likely to become valuable as timber, but that they will become matured at a comparatively early stage. Many of the newer coniferæ are found to bear seed at a very early stage, and, notwithstanding, continue to make fair progress; and from this many cultivators assert that this bearing of seed is no sure index that the species are of a weakly constitution in our climate. Our own opinion is, however, in respect to such of the newer coniferæ as bear seed very early, that they are weakly-constitutioned in our climate; and the fact that the plants reared from such seed are very deficient in vitality, and generally diseased, proves this beyond a doubt.

2104. The *sixth* symptom of disease in trees is *dropsy*. This disease most generally takes place in forest-trees, either where the soil is too rich for them, or where there is an excess of moisture about their roots. The cause of it appears to be that the roots take into the system of the tree an excess of juices, which the bark and leaves cannot assimilate. In this disease unnatural swellings are observable on some parts of the stem, which begin to rot and throw off the bark. It often also happens that the leaves will be found dropping off in their green state, and then the tree will be found to die suddenly. We have frequently seen this the case with the oak, where planted in a very rich soil with abundance of moisture. In this disease, where the bark becomes detached from the wood, there will be found a reddish-coloured water between the wood and the inner bark. We consider it incurable; and the only thing is to prevent it by attention to the ground being well drained and not over-rich.

2105. *Seventh, Ulcers.* This is a disease in trees which very much resembles the last; but it is mostly confined to the larch and to some others of the coniferous tribes. Its appearance is that of a running sore upon the side of the stem, where the natural juices escape in the form of a hard resinous matter. This disease is mostly found upon young trees of these tribes, and is frequently occasioned by insects lodging their eggs in the inner bark, where the young live for a time, and destroy the alburnum. We have frequently observed this disease take place in young larch plantations, where the soil was in a condition unfavourable to their growth.

2106. *Eighth, Wounds.* It sometimes happens that trees will receive damage on their stems by having the bark peeled off by accident in some way or other, which may prove injurious to their health, and not unfrequently be the cause of death. Any tree in a healthy state is not easily injured by an external wound upon the bark, unless, indeed, that be so extensive as completely to strip the tree of its bark all round at any given part—as is frequently observable in the case of cattle stripping the bark off to a considerable extent—when, of course, a tree must be much injured, and will gradually decline in health, and ultimately die. But this is an exception to wounds of a general nature; and any simple damage received upon the bark of a healthy tree in all cases soon heals up, and is only of a temporary nature. The case, however, is very different with an unhealthy tree which may receive an apparently simple wound, such as a piece of the bark or even a large branch broken off. In a case of this nature, when the sap of the tree injured is in a diseased state previously, the wound made becomes, as it were, a running sore; rot will sometimes be induced at the part, and a gradual decaying of the whole tree will take place. This state of a wound in a tree does not often occur; but we have known it to take place, and that in trees which were in a state of dropsy. As we have already said, however, any simple wound made upon a healthy tree is seldom or never found injurious, but soon heals up.

2107. *Ninth, Stunted growth of the young wood.* This state of a tree is at once apparent by the very short annual growth of young wood upon all the lateral branches, and may be in general the natural result of any of the diseases already described. Every healthy tree in a fair growing state, if not arrived at natural maturity, ought to make annual growths of new wood, upon the lateral and top branches, of from 6 to 30 inches, according to age and species. If, however, a tree of 30 years of age makes shoots of 12 inches annually, and soon after that period is found to be making shoots of 4 inches only, there is reason to suspect that it has become suddenly unhealthy. The cause must be sought for in some one or other of the diseases already mentioned, and a remedy applied accordingly.

Every tree when it has attained the full size and development of its nature, however healthy it may have hitherto been, gradually begins to fail in making young wood. This is the work of time, doing to the old tree what disease does to the young.

2108. There is very little danger indeed of trees being destroyed by disease, provided they are planted upon a soil properly fitted to their nature. This, generally speaking, it is in the power of the intelligent forester to accomplish—by drainage in the first place, and by a judicious selection and adaptation of the different kinds to the different descriptions of land; and not less important is a judicious application of systematic thinning afterwards.

SECTION III.—CAUSE OF DISEASE AMONG LARCH PLANTATIONS.

2109. It is our opinion that there is no tree cultivated in Britain more worthy the attention of landed proprietors than the larch. There are very few purposes for which oak is now used for which larch would not answer as well. It is a rapid-growing tree, and attains maturity long before the oak. We have seen larch-trees little more than 30 years old sold for 60s. each, while oaks of the same age, and growing upon the same soil in the same neighbourhood, were not worth 10s. each; and this at once points out the advantage of planting larch where immediate profit is the object. The larch has been held in high estimation in former times, as we learn from several old authors. The first mention made of the cultivation of this tree in England is by Parkinson, in his *Paradisus,* in 1629; and Evelyn, in 1664, mentions a larch-tree of good size at Chelmsford in Essex. It appears to have been introduced into Scotland by Lord Kames in 1734. But the merit of pointing out to the proprietors of Scotland the valuable properties of the larch as a timber-tree for our climate, appears to be due to the Duke of Athole, who planted it at Dunkeld in 1741. The rapid growth of these, and of others of the same species, afterwards planted in succession by that nobleman, as well as the valuable properties of the timber of the trees that were felled, realised the high character previously bestowed upon the larch by foreign and British authors, who were followed in their opinion by others, such as Dr Anderson, Watson, Professor Martyn, Nicol, Pontz, Sang, and Monteith—all confirming, and further extolling, the valuable properties of the tree. It is no wonder, therefore, that the larch has been planted so extensively in Great Britain of late years in almost every kind of soil and situation, and under every variety of circumstances capable of being conceived in forest management, seeing that its culture has been so much recommended by men in whose opinions landed proprietors put much confidence as regards forest matters. We say that it is in a great measure owing to the advice of such men as we have above named, that the larch has been so extensively planted within the last eighty years. According to their opinion, it was one of the hardiest, and most easy of culture, among our forest-trees; and proprietors, relying too implicitly in this matter upon the soundness of these opinions, planted larch too indiscriminately upon all kinds of soil, without having due respect to the nature of the tree: for the larch, as well as every other tree, is influenced by a natural law, which restricts it to particular states of soil, in order to develop itself fully and perfectly; and from neglect of this the various forms of disease now so prevalent in the larch have chiefly originated. It is well known that, in many instances, whole plantations of larch-trees have died—we may say almost suddenly; and in many instances, the return made by it has been far inferior even to the Scots pine.

2110. For some years past much has been said and written relative to the nature and cause of the unhealthiness still prevalent among our larch plantations; but, despite all that has been written upon the subject, we are not aware that anything as yet really satisfactory has been the result, at least so far as to cause any likelihood of a really permanent improvement in the cultivation of the tree for the future. We may therefore here be allowed to give our opinion as to the cause of the unhealthiness which appears still to prevail to a considerable extent among one of the most useful of our timber-trees. Many who have written upon this most important subject assert that, from the circumstance of the larch not being a native, it is fast degenerating in our country; and, in illustration of their argument, they point out the healthy development of many old original specimens yet remaining in different parts of the country. Such an argument as this is scarcely worthy of being confuted,—for we may as well say that the sycamore, which is not a native of Britain, ought to be fast degenerating also, which we know is by no means the case. Another answer to this assertion is, that in many places we find healthy larch plantations, and in other places unhealthy, both, nevertheless, being of the same age. Now, if the larch is indeed degenerating, why is it found to succeed well in one place and not in another, and that, too, even within the bounds of the same estate? The only reasonable answer that can be given to this question is, that wherever the larch is found thriving well, it must be growing in a condition of soil and circumstances agreeable to its constitution; and wherever it is not thriving, these must be unfavourable to it. Therefore, in our further inquiries as to the cause of unhealthiness in the larch, we must ascertain the nature of the circumstances which affect the tree in both cases; but before attending to this, it is necessary to consider briefly the nature of the nursery culture of the plants, from the sowing of the seed to the time that the plants are ready for planting out into the forest ground; afterwards, we shall consider the circumstances which affect the tree for health or for disease, in the treatment of it in the forest ground.

2111. First, then, we shall examine the treatment the young plants generally receive in the nursery. The seed is sown on highly manured and very rich soil, and as soon as the plants are formed their roots have a ready supply of food. This excites them to grow rapidly,—so much so, that very frequently at the end of the season they have attained heights of from 4 to 6 inches. Next year, when the plants are one-year-old seedlings, they are planted out on soil as highly manured and rich as that of the beds they were reared on, and, in consequence, the excitement to growth is continued, and at the end of the second year they are in many cases found from 12 to 18 inches high; and if they are kept another year on the same ground, they generally attain heights of from 24 to 30 inches; and thus, when only 3 years of age, they are of the heights specified, while, from their rapid growth, their wood is of a soft and open texture, and seldom so thoroughly ripened as it ought to be. These young trees are next planted out on the poor and generally exposed lands of the open forest, and the result is, that the sudden change from a very rich soil and sheltered site, to a poor soil and comparatively exposed site, has such a decidedly injurious effect upon the constitution of the plants as to throw the greater part of them into bad health, and thus disease is induced in them at the very beginning of their existence.

2112. That the plants thus reared on rich soil in the nursery do receive such a check as is damaging to their after-growth when planted out on poor land and exposed sites, is evident to the least experienced person who will take the trouble to observe their progress during the first few years after they have been planted out on their permanent sites. In the first place, a considerable proportion of them die, thus causing trouble and expense to make the crop good. This is persevered with, however, and a crop is established, but for the greater part the plants make very little progress during the next two or three years after—many of them, the first year, merely keeping in life, without making even 1 inch of young wood, while few of them make over 3 inches. The second year there is a slight improvement, a considerable proportion of them making shoots of from 4 to 6 inches; but not till the third year, generally speaking, are they found to make anything like fair growths, and even then only if the land is in a favourable condition for them, and the situation not very much exposed.

2113. Now, from this state of things in regard to the cultivation of the larch—and they represent the facts of the case—is it to be wondered at that the plants should become diseased, seeing that the seeds of disease are sown in their constitutions at the very outset, by their being unnaturally excited to rapid growth in the nursery, and afterwards subjected to a course of treatment quite the opposite? It is only according to the usual course of nature that it should be so; and still the same course is persevered with, and the general unhealthiness of the crops is the result. No doubt much of the after healthiness or unhealthiness of the crops of larch reared in this way depends upon the condition of the forest land on which they are planted: where that is suitable, the trees will ultimately succeed; where it is moderately suitable, the health of the crop will be of a medium description; and where it is decidedly unsuitable, the trees will of course be found decidedly unhealthy.

2114. The true way to rear a class of healthy young larch in the nursery is to grow them, both in the seed-beds and in the rows after, on *land in a fair condition;* not too rich to excite an unnatural degree of growth, nor too poor to cause the plants to be of a stunted character. This is the proper and natural way of dealing with the rearing of the larch ; and until this point is attended to in respect to the tree, disease in some form must attach to it and impair its future progress, less or more, according to the degree of excitement the plants are subjected to in the nursery, as above stated, and according as the forest land on which they are afterwards planted is suitable or unsuitable for their healthy development. In no case should one-year-seedling larch be more than 3 inches high, nor one-year-seedlings, one year transplanted, more than 10 inches, nor three-year-old plants more than 20 inches high. When the plants are much above these heights at the respective ages, there is every reason to conclude that they have been unduly excited by manure, and that they are likely to become diseased after being planted out on poor land and high sites, less or more, according to the suitableness or unsuitableness of the land. Plants of the sizes stated are always found more healthy and hardy than larger ones at the same ages, and therefore are not liable to become diseased when planted out on poor land and on exposed sites, as is the case with tall plants that have been excited by manures.

2115. The larch in its native countries inhabits the slopes of mountainous districts, in the lower parts of which it attains its largest dimensions. In its native mountains, the larch is never found prospering in any situation where water can lodge in the ground in a stagnant state; nor is it ever found of large dimensions in any extensive level piece of country having a damp retentive bottom or subsoil. On the other hand, the larch, in its native localities, is found luxuriating upon a soil formed from the natural decomposition of rocks; for there the surface soil rests upon a half-decomposed stony subsoil, through which all moisture passes freely in its descent from the higher grounds. In this state of things the roots of the trees always receive a regular supply of fresh and pure moisture, and, at the same time, the ground in which the trees grow is kept in a cleansed and wholesome state, not having any stagnant gas or water lodging in it; and this forms, in our opinion, the perfection of soil for the cultivation of the larch.

2116. We are convinced that any man who will compare the state of the land upon which a healthy plantation of larch is found (that is to say, one which has arrived at a considerable age, and is in a sound state), with what we have stated relative to the healthy state of trees of the same species as found in their native regions, will at once see the same circumstances acting in each case. Thus, in all cases of healthy larch plantations in this country, where the timber has attained large size, and is sound in quality, we find them growing upon a soil through which the water that may fall upon it can pass away freely; as, for instance, upon the slopes of hills, and even in hollows, upon a strong clay soil, but where there is a proper drainage for the ready and free passage of the superfluous water; and we have even cut down larch timber, of large size and sound in quality, growing upon a light sandy moss, 2 feet deep, which rested upon a stiff clay. In this case the moss was drained, and the water passed freely through the light soil; and the situation being upon a slope, there was a continual circulation of moisture passing along upon the top of the subsoil or clay. In short, we have found good larch timber growing upon almost all varieties of soil; but we never found it upon one which had not its particles constantly cleansed by the continual circulation of water passing through it, either by natural circumstances or artificial drainage. On the other hand, in all cases of diseased larch plantations, we shall find that the soil has either been badly drained or not drained at all. There must be ingredients lodging in the soil which act against the health of larch-trees growing upon it, and which can be carried off only by an effective system of drainage in order to make it fit for the healthy rearing of this tree.

2117. In a plantation on a level piece of ground upon the estate of Arniston, we had occasion to cut down some larches in the way of thinning. The plantation was then about 40 years old, and consisted of a mixture of larch and Scots pines. We found those which were cut in the central parts of this plantation, without exception, rotten in the heart, which was exactly what we anticipated, for the soil had never been drained; while some which were cut upon one side of the plantation that formed a sloping sandy bank, were found every tree sound, and of excellent quality of timber; and, at the same time, every tree in this position was at least three times as large as those planted in the interior level parts of the plantation, although all were of the same age. Now the cause of the superiority of the trees which grew upon the sloping bank may at once be seen from what we have already said upon this point. Again, another side of this plantation was bounded by a deep ditch, forming a fence upon the edge of a field; and all along this ditch upon the side of the wood, larch-trees of excellent size and quality were growing. Nothing can be more convincing than this, that in order to grow larch timber of sound and good quality upon land which formerly grew diseased trees, all that is required is to drain it, when success will be the result.

2118. We have always found larch-trees succeed better when growing among hardwood trees, than when growing by themselves or among pines, even although planted upon soil in the same state in both cases. The cause of this we conceive to be, that the roots of the hardwood, from their penetrating deeper into the earth than those of the larch, pine, or fir, have a tendency to divide the soil, and open it up for the more ready circulation of the water through it. It is indeed, well known to almost every forester, that the roots of the hardwood trees will penetrate through the stiffest soil, and considerably break up and improve it to the depth of 2 and 3 feet. It is to this that we attribute the generally superior health of larch found growing among hardwood, as compared with those among their own natural order upon the same quality of ground.

2119. From what we have said above, it will appear evident that disease in the larch is chiefly attributable to the want of proper drainage of the soil; therefore, in all cases where it is desirable to cultivate sound larch timber, the land should be drained with open cuts, as specified in Sections I. and II. of Chapter VI., according to the nature of the soil.

2120. For the healthy growth of the larch, however, it is not enough that the land should be drained merely to the extent of relieving it of superabundant water: the operation must be carried out on every part of it having the least tendency to retentiveness in the subsoil, as without this the crop will certainly not succeed. Indeed it is mainly to the neglect of carrying out drainage to the extent here indicated that a large proportion of the larch plantations in this country are found inferior in their crops, if not decidedly diseased.

2121. Within the last thirty years we have had large experience in the rearing of larch in all parts of Britain; and we have invariably found that where the land under this tree is deep, porous, and open in the subsoil, with sufficient drainage—either natural or artificial—to insure its being kept constantly in a dry and healthy condition, the crops are healthy and promising; while, on the other hand, we have as constantly found that where larch has been planted on land which is thin, and resting on a retentive subsoil, although apparently dry, the crops are less or more unhealthy, according to the degree of retentiveness, and its consequent coldness and wetness. Therefore we maintain, that where plantations of larch are found unhealthy, it is the fault of the planter that they are in such a condition; for, had he drained the land before he planted the crop, and that in such a thorough way as to open up the subsoil and render it porous and dry to a considerable depth, the crop would doubtless have been a perfect success, and have repaid its proprietor a hundred per cent on the outlay.

2122. The larch is a plant that can stand against any degree of cold in the atmosphere of Britain, but it cannot resist uninjured the effects of the retentive damp and cold soils upon which it has been planted; hence its frequently becoming diseased with us. The temperature of the air is generally understood by foresters, and is admitted by them to be an important consideration in respect to the growth of trees; but the temperature of the ground, which is certainly not less important as regards the health of trees, is not generally recognised as a necessary point to be considered by them. They seem, generally speaking, satisfied to look at the surface of things, without giving a thought to the fact, that unless the ground is kept warm for the roots of trees, they cannot maintain robust health in it. Indeed there can be no doubt that the greater part of the diseases that are found to prevail in our larch plantations proceed from the *deficient warmth about the roots* of the trees, so that when cold cutting winds and slight frosts set in in spring, they are unable to resist the attack; their vessels shrink, their fluids become deranged, and disease follows as the natural result. Often, for example, in the months of April and May, we get a few days of bright sunshine, causing the larch to throw out its leaves; such days are frequently succeeded by frosty and cold nights, which injure the leaves of the larch: when its roots are in a cold, retentive, and undrained soil, the plants cannot stand this sudden change, but become diseased in consequence; whereas, when they are in a warm, dry, and congenial condition of soil, the living principle of the plant soon repairs the damage, and no harm ensues. Now, in order to secure this favourable condition of land for the healthy growth of the larch, *it must be thoroughly drained wherever wet, and wherever it is of a retentive nature in the subsoil,* as this will insure its being gradually made porous for the free passage of water through all its parts; while at the same time it will render it capable of absorbing a large amount of heat, and thereby promoting all the conditions of soil most favourable to the healthy development of the larch, which it could not before drainage.

2123. But besides the neglect of drainage, there is another cause of the diseased state in which a large extent of our larch plantations is found—viz., the neglect of thinning; for it is quite evident that, however well the land may be suited for the healthy development of this tree, if no proper attention be paid to give the crop due space for the growth of each individual, disease must ensue as a natural consequence.

2124. Since the publication of the last edition of this book, we have examined a very large extent of larch plantations in England, Ireland, and Scotland, and are glad to have it in our power to record here that we have found on most of the properties we inspected that larch plantations are now being very much better attended to in the way of thinning than they formerly were, and from this we have every reason to believe that an improved state of the health of the crops will be the result.

2125. Generally speaking, we have observed that where the land is naturally, or has been artificially made, in a good condition for the larch, the trees grow healthily and well so long as they have proportionate space for the spread of their roots, and for that of their branches; and that when proper attention is paid to them in this respect, they never fail to become valuable as a crop: while, on the other hand, those planted in an equally good condition of soil, but which had not been attended to in the way of thinning, become diseased at a comparatively early stage; thus exemplifying that, in order to prevent disease in larch plantations, it is not only necessary to render the land wholesome by drainage, but also to thin judiciously as the crop advances.

SECTION IV.—SHOULD THE LARCH-PLANTS WE USE BE REARED FROM HOME-GROWN OR FROM FOREIGN SEEDS?

2126. This is a question of very considerable importance to every British planter, and therefore we think it proper to devote a short section as an answer to it. In referring to the seed of the larch in the section describing the management of the nursery, we state "that the best larch-seed that is generally collected from trees grown in this country is unfit for growing, to the extent of from one-third to nearly two-thirds of the number of seeds it contains; and as a rule, it generally follows that the greater the number of healthy seeds there are in a given weight of the seed, the more healthy and robust are the plants from it." Then, from the fact that so large a proportion of the seed of the larch taken from trees grown in this country is unsuccessful, it is to be inferred that the trees are, in an equal proportion, of a weakly constitution, and unfit to produce seeds of sufficient vitality to vegetate.

2127. On the other hand, every cultivator of the larch from seed is aware that nearly all the seeds he procures of this tree from Germany are found to vegetate readily and freely, very few of them ever proving abortive; thus showing that the trees grown on their native habitats have a very much greater degree of the vital principle in them than those grown in this country, and that, in consequence, their seeds are more healthy, and therefore better fitted to produce a vigorous-growing class of trees. These are facts which speak for themselves in our everyday practice in dealing with the larch, and having premised these points, we unhesitatingly state as our answer to the question given at the head of this section, that *the larch-plants we use should be reared from foreign seed.*

2128. We are well aware that many argue against this, and say that larch-plants raised from home-grown seed are much hardier, and therefore better suited to our climate, than plants raised from foreign seeds. That plants reared from seeds taken from trees grown on the cold and mountainous districts of Britain are hardier than plants reared from seeds taken from trees grown on the warm plains of Germany we readily admit; but that plants reared from seed procured from trees growing on the mountainous districts of the continent of Europe are less hardy than plants reared from home-grown seed is not to be admitted, as all our experience goes to prove that larch-seed procured from mountainous districts on the Continent produces plants at least as hardy as any plants of the same species reared from the best home-grown seed.

2129. Seeing, then, that our home-grown larch-seed is, generally speaking, defective to a very large extent, we ought to procure our supply of it from the mountainous districts of Germany, where the crop of this tree is well known to be of a healthy, hardy, and robust character, and the seed of a description in all respects likely to produce an equally good class of plants when grown in Britain.

2130. With trustworthy seeds taken from trees growing on the mountainous districts of the continent of Europe, whereby we could secure a healthy and robust stock of young plants; with proper and natural treatment of the plants in their nursery culture; and with the forest lands properly prepared by drainage for the after healthy development of the trees,—we could not fail in time to have a class of larch plantations in this country of the most valuable description possible. In attending to the matter of the collecting of the seed, however, great caution requires to be used to see that it shall not be taken from trees growing on the warm plains of the native country of the tree; for if it should be gathered from such districts, it would follow as a natural consequence that the plants reared from it would be somewhat tender in our climate; and of this we have had ample proof in our own experience. Therefore, in short, to have the best class of larch-plants, we must procure our seed from the healthiest trees on mountainous parts of Germany, and avoid taking it from trees growing on the level and warm parts of the country.

2131. Since the publication of this section in the last edition of this book, we have had many expressions of opinion from nurserymen, landed proprietors, and their foresters, in respect to the rearing of our larch-plants from seeds procured from the mountainous districts of the Continent, and we are glad to say that all who have communicated with us on the subject agree with our views as stated here. And, further, we have reason to believe that all intelligent nurserymen now rear their larch-plants from seeds procured from the mountainous parts of the Continent. This, we may remark, augurs well for the future of larch-plantations in Britain.

SECTION V.—HOW TO KNOW LARCH SEEDLINGS OF A SOUND AND HARDY CONSTITUTION.

2132. When a forester goes to purchase larch-seedlings from a public nursery, he should be very careful to observe whether the stock of this class of the tree in it is all of a sound and hardy nature, or otherwise, before ordering any from it. This is a point which can be easily ascertained; and as every forester ought to be able to distinguish whether the larch-seedlings he buys are of a sound and hardy class, or otherwise, we shall here state, for the guidance of such foresters as may not have experience in this important matter, how they may know tender from hardy constitutioned larch-plants.

2133. We shall suppose that the forester goes to a nursery to examine the seedling-larch in the month of November, which is the proper season for the purpose. In attending to this he must be very particular to see whether the stems of the plants are well ripened or not—that is, if the stems are well ripened, they will feel firm, and even hard and rough, when taken between the forefinger and thumb; while, if they are not well ripened, they will feel soft, yielding, and smooth when pressed and drawn through between the finger and thumb. Besides, when the stems are well ripened, the buds will all be found large and well developed and also hard when pressed between the finger and thumb, but if not well ripened, they will feel soft and yielding when firmly pressed. Then, having thus examined the plants and ascertained their condition, the forester will be able to decide accordingly—that is, if he find the plants all firm and hard in their stems, with the buds well developed, and also hard, he may conclude that they are well ripened, and that they are therefore of a sound and hardy constitution, and likely to produce a satisfactory class of trees. In such a case he may purchase without any hesitation. But, on the other hand, if he should find the stems of a considerable proportion of the plants to feel soft, yielding, and smooth when pressed between the finger and thumb, and their buds soft also, he may conclude that they are of a very defective constitution, and too tender for being safely used, and from this he should reject them at once.

SECTION VI.—INJURIOUS EFFECTS OF SMOKE AND OF NOXIOUS GASES UPON TREES.

2134. It is a well-known fact that the smoke and gases from various chemical works, lime-kilns, furnaces, and other establishments of the kind, are more or less injurious to all classes of vegetation in their neighbourhoods; and as we have frequently been called upon to give our opinion as to the extent of damage done to trees and plantations from this cause, we think it may not be out of place for us, in a work of this kind, to give a few statements as to the external symptoms on trees affected by such gases.

2135. Trees affected by noxious gases issuing from works of the nature stated above, ere long become of a stunted habit of growth, in consequence of these gases interfering with the healthy action of the leaves, and thereby preventing the complete formation of the tissue of the young shoots. This state of the subjects will take place less or more according to the nature of the works and the gases they give out, as well as according to the distance they may be from the works; and to a considerable extent the action of the gases is modified by winds, and by wet and dry seasons.

2136. In all cases where the health of trees is being injured by noxious gases, there is a natural tendency in the subjects to throw out young shoots on their stems and larger branches, which in time are also injured by gases, and thus the trees gradually assume the stunted appearance referred to. This tendency of the trees to throw out young shoots is caused by the leaves and young shoots proper being unable, in their weakened condition, to elaborate the sap as it ascends, and thus it is thrown back into the system of the trees, which make a natural effort to relieve themselves of it by the formation of new growths.

2137. At first the young shoots referred to come out from the stems and large branches only, but if the trees are subjected for a number of years to the damaging influences of the gases, they break out on the bottoms of the stems also, and chiefly at the junction of the stems with the roots. In short, under such circumstances these growths come out from the old bark on most parts of the trees affected.

2138. All trees are not, however, affected by such noxious gases alike. As a general rule, trees with thick, hard, and glossy leaves are less injured by them than those having soft and downy or hairy leaves; and deciduous trees are less injured than those that do not shed their leaves.

2139. Trees injured by noxious gases in the way described above may, however, be found perfectly sound in their internal structure, whether in regard to their roots or stems, and therefore, if the cause of the damage has not been long in operation, and is removed within a reasonable time, they may again resume their former health, and be made to become well clothed and handsome trees.

2140. Trees not naturally in good health, whether from unsuitableness or wetness of soil, are more easily injured by noxious gases than others of the same sorts that are in perfect health. We have often had occasion to remark this in our examinations of subjects so situated, and therefore think it right to note the fact.

2141. Trees growing on land in all respects suitable to their respective natures will resist the effects of noxious gases for a considerable length of time—for years—while those in a contrary state of things will be damaged in a comparatively short time, and may indeed be killed.

2142. Trees growing in a crowded plantation will be injured very early where they are exposed to the influences of noxious gases, while those standing in a well thinned plantation, where each has plenty room for development, will resist their effects for a long time.

2143. We have seen plantations within 200 yards of chemical works in perfect health, while others 500 and 700 yards off them were much injured—showing all the indications of damage referred to in the foregoing part of this section; and this was brought about in the first case by the trees being on suitable soils, while in the second cases they were on unsuitable soils; therefore, in order to pass a fair judgment in all such cases, all the circumstances stated should be taken into consideration.

2144. It is scarcely necessary to say that where it is desirable to recover the health of trees affected by noxious gases, this can only be brought about by the removal of the cause; and afterwards by pruning off all diseased growths, scraping off all the outer bark, and washing the whole with tepid water.

SECTION VII.—DESCRIPTION OF SOME OF THE INSECTS THAT ARE FOUND INJURIOUS TO FOREST-TREES.

2145. The subject of forest entomology is one with which the British forester of the present day is far too little acquainted. A general knowledge of the nature and habits of the numerous insects which are found injurious to plantations would be of great benefit to him, and would enable him to devise the best means at his command for their destruction. The object of the forester, however, should be that of becoming so familiar with the natural history of these insects as to enable him successfully to use such measures as will prevent the attacks of the insects upon the plantations under his charge.

2146. We do not mean to infer that foresters require to be entomologists in all the branches of the science, but that they ought to be in possession of such a degree of knowledge of the subject as pertains to their own daily work and duties in dealing with the insects found injurious to forest-trees.

2147. In a work of this kind it would be out of place to enter fully into detail in respect to all the insects that are found to attack our forest-trees. Such descriptions must be sought for and obtained in works specially devoted to the subject. We may here remark, however, that it is to be regretted that up to the present time there is no really proper manual devoted wholly to the subject of forest insects. Although there are many very useful works upon insects, yet we are not aware that there is any one adapted specially for foresters. Such a want is felt more so now that foresters in general are beginning to endeavour to become better acquainted with the various branches of their profession. We trust that before long a complete manual, specially devoted to the subject, will be issued.

2148. In the present section we can only refer to those insects which are known to do most damage to our various forest-trees, and our remarks upon them must of necessity be brief. We will take them up in groups corresponding to their classification and natural habits; and in doing so we will merely treat them in a popular and non-scientific way.

2149. I. *Homoptera.*—In this order of insects there are two groups which are of special interest to the forester, and these we will take up separately. The *Aphides,* or Plant-lice family, is a very destructive one to the vegetable kingdom in general. They possess an extraordinary power of multiplication, and are the means of wholesale destruction, hardly any kind of plant being free from the attack of some species. We can only mention two species.

2150. *Adelgis laricis,* or the Larch-bug.—This insect is now well known among foresters in general. It usually appears upon the larch about the beginning of May, and soon seems to be enveloped in a whitish coating like filaments of cotton. The insects are sometimes found so plentiful upon the larch as to give the trees a white appearance all over. During the whole season they go on producing eggs, until enough have been produced in order to carry on the work of destruction in succession to their parents. The insect itself is small; but owing to its great numbers it does incalculable damage to plantations. According to Loudon, it was observed on the larch at Raith, in Fifeshire, about the year 1785, and first appeared in the Athole plantations in 1795. It will generally be found that this "blight" is abundant upon unhealthy trees and plantations, while it is seldom found upon healthy and thriving ones. We need not enter into arguments regarding the various opinions held by foresters and others upon this subject, but merely mention that, in our opinion, the attacks of this insect might be rendered of little consequence if the plants received proper treatment when in the nursery, and also in planting them out upon their permanent sites.

2151. *Aphis cratægi*, or the Thorn-fly, is merely another species of this family, which frequents young thorn-hedges, and also is to be found in nurseries among the thorn plants. This insect is the cause of much damage to these plants, in a similar way to that done by the larch *Aphis*.

2152. The beech is also often found infested by a species of *Aphis*, both on the bark and leaves, as are also the poplar, elm, lime, and willow. In short, as we have already remarked, few plants are free from their attacks.

2153. The *Aphis* family of insects emit what is generally known as the *honey-dew*. This substance they extract from the sap of the leaves, and afterwards eject it in a purified state. It is often found to such an extent as to spoil the appearance of the trees on which the insects are numerous, and is the means of attracting swarms of ants and other insects to the trees.

2154. The *Coccidæ*, or Blight-insects, belong to the same order (*Homoptera*) as the *Aphides*. It is to this family that the scale, so common upon different species of our forest-trees, belongs; and as this insect is already referred to under paragraph 2102 of this work, we need not repeat here what has been there described. It is only necessary to mention that there are numerous species of these minute insects, which attach themselves to the bark and leaves of many different kinds of trees and shrubs, and that they are the cause of great destruction if some means are not adopted for the prevention of their attacks.

2155. II. *Trachearia.*—In this class we have the *Acaridæ*, or Mite family. Of this group of insects there is at least one species which often infests the bark and leaves of many trees. We refer to the red-spider (*Acarus telarius*), which is a minute insect, to be found under the bark and upon the leaves of such trees as the elm, poplar, lime, spruce-fir, and Scots pine. It will be noticed that they cause the leaves of trees attacked to turn brown, and generally to fall off altogether; so that in this way many trees are weakened, and their bark injured, by the insects. They abound chiefly in dry, warm weather, and are seldom to be found during a wet season.

2156. III. *Coleoptera* (Sheath-winged insects or beetles) is a very extensive and important order, and includes many of the worst enemies of our woods and plantations. The name of the order is derived from the insects having the first pair of wings crustaceous, and serving as a covering to the true wings, while the latter are not in use. However, some of these insects are without wings or sheath; but in general they are provided with these: hence the name of the order. We have only sufficient space to mention a few of the more important species, or such as are of most interest to the forester.

2157. *Hylurgus piniperda*, or the Pine-beetle.—This destructive little insect is only about one-sixth of an inch in length, nearly black in colour, downy, and cylindrical in form. It is very injurious among pine plantations at nearly all stages of their growth, and until the trees are well advanced in age. Not only does it attack the young branches on the trees, but it also is to be found among decayed branches, if left lying in the plantations. It lays its eggs under the bark of felled trees and branches of different kinds, and ascends the growing trees, doing much damage to the young shoots of pines, larch, and firs. We cannot do better than take the liberty of quoting from Miss E. A. Ormerod's 'Notes of Observations of Injurious Insects,' for 1879, where this insect is figured, and the following remarks made upon it: "They attack the annual growths on the extremities of the branches, by boring from the side of the tender shoot into the pith, and then follow the pith for an inch or two towards the point of the shoot. This is done in summer; and the following spring, during high winds, these shoots are blown off. The injury to side-shoots is bad enough; but the effect of the leading shoot being blown off is for the trees to be often bushy-headed; and when the tree is thus affected, it retards it in growth, and reduces its ultimate value. When young fir plantations are thinned, all the brush ought to be at once removed or burnt on the ground, as this beetle propagates in the decaying branches in legions. They ascend the standing trees, and commit extensive ravages. When fir-thinnings are carted from the plantation, it is a very common practice to dress the bark off to lighten the carriage in transit to market. The dressing-off of the bark should not be permitted within the plantation. In a year after the ground round these heaps of bark may be seen covered with grown shoots, blown from the growing trees, bored by the beetles which the heaps have matured." The plants attacked are easily known by the twig in which the insect is at work falling to a side and becoming soft and withering. The only way to get rid of them is to take off the twigs affected as soon as they are observed, taking care to kill the insect in each case.

2158. *Hylobius abietis*, or Fir-weevil.—This insect is about half an inch in length, black coloured, with bands of downy yellow on the back. It has a long proboscis, and is somewhat cylindrical in form. It is fully more destructive in its habits than the beetle already referred to, as it is generally much more numerous in pine woods. It does not confine its attacks to pine plantations, however, although it seems to have a preference for them, but is found to destroy larch and fir, as well as several kinds of hardwoods. It is found to be most numerous in pine plantations that have been lately cleared of a crop of the same kind of timber—that is, where it has been replanted within four years after the clearing. Gradually as the old stumps and roots of the former crop decay, the insect becomes less numerous. If the *débris* is allowed to lie on the ground, it is sure to encourage the breeding of the insects; so that these should all be removed in order to lessen the probability of their attacks. We quote the following from the 'Journal of Forestry:' "The early stages of the life-history of the insect are not very clearly defined by entomologists; but the female is supposed to burrow deep in the ground, and there deposit her eggs on the roots of pines and firs; and the passages of the larvæ appear to confirm the supposition, as they generally run upwards. The larvæ, or grubs, live upon dead wood, and are not known to attack living young wood. The favourite resorts of the perfect insect in the winter season are the stumps of felled timber, beneath the timber itself if allowed to lie on the ground, and especially among heaps of dead branches which have been permitted to accumulate in the plantations. The beetles gather in great numbers in such places early in the autumn, at which time the females lay their eggs. From these hibernating quarters the perfect insects issue in vast numbers, at various periods from May to August, and commit great havoc among young pine-trees, ravenously devouring the young living growth, and either killing the trees outright or so seriously injuring them as to render them worthless as a crop, and making it necessary to destroy them and replant with sound, healthy stock." This insect does most damage in dry, warm seasons, eating the bark from the stems of young plants in patches and in spiral lines all round each stem, which injures the health of the plants, causing, when they are numerous, a large proportion of a whole crop to die. It also attacks old trees as well as young plants, but does not do the former much harm, as the wounds soon heal up. It is found plentiful in old pine or fir woods, and only lives in a district as long as it has fresh bark, or bark in a certain state of decomposition, to live on, and is never found to any considerable extent on land that has been a few years cleared of its crop of pine or fir trees.

2159. *Melolantha vulgaris*, or the Common Cockchafer.—This is a very obnoxious insect, which commits great depredations among both hardwood and coniferous trees, among which we may mention the oak, sycamore, maple, lime, beech, willow, and elm. When in the larva state, this insect does great injury to the young roots of trees, and also eats the bark of the older roots. After remaining for years in this state, it becomes a full-grown beetle, and commences to eat the leaves of the trees already mentioned, but seeming to prefer the leaves of the oak before those of any other tree. It is an insect generally well known as a destroyer of the roots and leaves of trees and shrubs. There is another species of this kind of insect—the

Melolantha hippocastani — which is specially destructive upon the horse-chestnut.

2160. *Scolytus destructor.*—This beetle deposits its eggs between the soft wood and the inner bark of hardwood trees, but chiefly upon the elm. The female bores through the bark about the month of July, and there makes her abode, after which the larvæ are hatched in the autumn, and immediately commence to eat the inner bark of the tree. This they continue to do until the following spring or beginning of summer, when they emerge through the bark perfect insects, and afterwards pair, the females boring into the bark as before, and laying her eggs, in order to continue the species. The result of the attacks of these insects is, that the sap of the tree is hindered from ascending and descending, and by this the trees become diseased, and often die altogether. Trees infested with the *Scolytus* have the appearance of the bark having been riddled with shot; and very fine sawdust will be found either at the bottom of the tree or upon the bark. They never attack dead trees, but seem to prefer young and vigorous ones, although they have been known to be upon unhealthy trees also. Of this insect there are several other species, including *Scolytus ligniperda,* which preys upon some of the conifers; *S. intricatus,* which attacks the oak; *S. vittatus,* the lime; and *S. fraxini,* which is an enemy to the ash. All these insects commit their ravages in much the same way as the one we have described, boring into the bark of the trees which they attack, and thus destroying their healthy action.

2161. *Bostrichus topographus.*—This is a small but very destructive beetle, of a dark colour, which commits great havoc among pine and fir woods. Its mode of working upon the trees on which it feeds is much similar to that of the *Scolytus,* and the general results of its attacks are nearly the same. It bores into the bark, and lives upon the soft inner substance, and is often found in such numbers as to be the means of wholesale destruction in the districts where it abounds. It is said to prefer the silver fir to other coniferous trees, but we believe that it does not confine itself to that tree much more than to any others of the pine and fir tribe. There are also many others of this genus which prey upon the different kinds of conifers —for example, *Bostrichus pinastri,* upon the pines; *B. laricis,* upon the larch; *B. cembræ,* upon the *Pinus cembra,*—and some others which we need not mention, as the habits of one will give a fair idea of all the others.

2162. *Pissodes notatus,* or Pine-eating Weevil.—This insect is also very destructive to pine and fir trees, by boring through the bark and into the solid wood. It is much similar in its mode of attack to *Hylobius abietis,* and lives upon newly planted fir-trees in the same manner as that bettle. Older trees are not free from it, however, as it is often found eating the bark of the branches of these. As with the other kinds of beetles mentioned, there are numerous species of this genus also, all more or less destructive to coniferous trees. *Pissodes notatus* breeds among decayed trees and branches in general.

2163. Besides the foregoing insects which we have mentioned, there are numbers of other beetles which do injury in one way or another to trees and shrubs. Among these we may mention the larvæ of a species of click beetle (*Agriotes*) which is known as the wireworm. These wireworms are very hard, and are yellow in colour. They commit great damage to young trees in our nurseries by eating the roots; and as they remain for several years in the larva state, it is difficult to get rid of them.

2164. IV. *Lepidoptera* (Moths and Butterflies).—There are numbers of these interesting and beautiful insects which do great damage to trees of various sorts; and to enumerate all the species would take a whole volume by itself. We will only mention a very few of them, therefore, or such as do most mischief to our forest-trees, and are generally to be found in our woods. This order of insects derive their name from a conspicuous peculiarity of their wings, the ordinary membrane of these being covered with a number of minute scales, placed like the tiles on a house-top. They are generally supplied with brilliant colours which are situated in these scales.

2165. *Bombyx gastrophaca processionea*, or the Processionary Moth. —This moth is very injurious to the oak, the larvæ constructing a nest upon the branches. They are hairy, with stripes and yellow spots upon the back, and are much similar to the common caterpillars seen upon fruit trees, the perfect insect of which is called the lackey moth. These insects live upon the leaves of the oak, and are often found in considerable numbers upon one tree. They derive their name from being said to proceed in regular order, the one after the other, in search of food. To the same genus belongs the Buff-tip Moth (*Bombyx pygœra bucephala*), which destroys the leaves of several species of hardwoods; and the Satin Moth (*Bombyx liparis salicis*), which does great damage, especially among willows; as well as several others which feed on the leaves of pines and firs.

2166. *Retinia Turionana*, or Pine-bud Tortrix.—This moth, or tortrix, is very injurious to the buds of pine-trees, and threatens to be as great an enemy to the forester as the pine-beetle. We will quote the following description from Miss E. A. Ormerod's 'Notes of Observations of Injurious Insects,' already mentioned: "This moth is somewhat under an inch in the expanse of the wings; the fore wings bright orange, with several irregular or bifid transverse silvery streaks; the hind wings dusky lead colour. The larva is glossy, of a dark purplish brown; the head, the transverse patch on the second segment, black. When full fed it turns to pupa in the pine-bud on which it has been feeding." This species, as well as the others of its genus, do great mischief by laying their eggs in the buds of the pines, so that when the caterpillar emerges it immediately begins to eat both the buds and the pith of the young shoots. It is not easily detected, and invariably does much harm before it can be noticed. This genus attacks not only the Scots pine, but the *Pinus austriaca*, *P. insignis*, and some others. Among several species, the more common and injurious are *Retinia Buoliana*, *R. resinella*, and *R. hircyniana*, the habits of which are all similar to the one now described.

2167. *Tortrix viridana.*—The caterpillar of this small green species of moth lives upon the leaves of oak-trees. "The moth varies in the expansion of its wings from 7 to 13 lines; the anterior wings are pale green, with a whitish margin in front; and the posterior wings brownish. . . . The caterpillar of this moth rolls up the oak-leaves in a very ingenious manner, so as to form a very commodious retreat—in which, indeed, it ordinarily resides, the centre of the roll being open; its diameter is proportionable to that of the body of the insect, and the roll is secured by various little packets of silk attached to the body of the leaf, and to the adjoining part of the roll."—*Loudon.* In many cases they strip oak branches almost entirely of their foliage, eating the leaves of the trees which they live upon in such a way as to do much injury to them, and prevent them performing their natural healthy action.

2168. *Cossus ligniperda*, or Goat Moth.—This large moth, which is commonly known by the name of Augur-worm in Scotland, is one of the worst enemies to several species of hardwoods that we know of. It attacks the elm, oak, willow, poplar, ash, alder, walnut, beech, and lime—the larvæ drilling holes through the bark and into the timber, finally causing the tree to become unhealthy; and as the holes are usually very large, they, combined with other causes, very often bring about the death of the tree. They may be often found boring into the heart of such trees as the willow and poplar, as they seem to prefer these to the others we have named, and in many cases the trees become riddled with these holes. The insect derives the name of goat moth from the disagreeable smell which the caterpillar emits; and this proceeds from a juice which it expels from its mouth, supposed to be for softening the wood as it goes along. The goat moth is thus described by the author from whom we have already quoted: "About three inches in expanse; fore wings rich brown, varied and mottled with darker markings, crossing the wings in waved lines; the hinder wings somewhat similarly marked, but of a dull pale brown. The caterpillar is flesh-coloured in its early stage, with a black head, and broad dull red stripe down the back; the colouring becomes more definitely red on the back and orange at the sides as the caterpillar gets towards full growth, when it is as much as three or four inches in length."

2169. *Zeuzera æsculi*, or the Leopard Moth.—The leopard moth is smaller than the immediately foregoing one, being about two and a half inches in expanse. The wings are almost transparent, of a whitish colour, and with dark spots upon them, those on the hinder ones being less noticeable than the spots upon the fore wings. The body of the insect is grey, and upon the thorax are six black spots. The name of the moth is evidently derived from the many spots which are upon the wings and the thorax or second segment of the insect. The larva is of a yellowish-white colour, dotted with black spots, while the head is dark coloured. The destructive habits of the leopard moth are much the same as those of the goat moth, the caterpillar boring its way into the trunks of the oak, birch, horse-chestnut, beech, walnut, lime, willow, poplar, elm, alder, and laburnum, as well as pear and apple trees. The egg is laid upon the bark, and the young larva enters the wood by a small hole, making its way through the centre of the wood, and forming a regular cavity as it goes along. It is said to remain for at least two years in the larva state, shortly after which it comes out a perfect moth. The eggs are laid in the autumn, and the caterpillar is of full size about June of the year following.

2170. We need only mention one or two more moths, which perforate the branches of some trees in a similar way to that which we have already described. These are the Red-belted Clearwing (*Sesia culciformis*), which attacks the birch; the Red-tipped Clearwing (*S. formicæformis*), common amongst osier beds; the Hornet Clearwings (*S. bombiciformis*, *S. apiformis*, and *S. tipuliformis*), living upon different species of deciduous trees. Besides these, many other moths and butterflies are injurious to the leaves of trees and shrubs, but we have mentioned sufficient to give an idea of their habits.

2171. V. *Hymenoptera* (Membrane-winged Insects).—The distinguishing characteristics of this order are, among others, that the anterior and hinder wings are hooked together during flight, and that they have an appendage at the tail in the form of a sting or of an ovipositor. Numbers of them come under the attention of the forester, as committing destruction upon many kinds of trees. Although divided into groups, differing from one another in some points, yet for our present purpose we will only select a few species which are particularly destructive among forest-trees.

2172. *Lophyrus pini*, or the Pine Saw-fly.—This is one of the most ravenous of the pine destroyers that we know. It chiefly attacks the leaves of the Scots pine, devouring them down to the bottom of the leaf, and completely disfiguring the branches. This they do when in the larva or caterpillar state, numbers of these appearing on one branch, and proceeding from one to another until they have the tree entirely bared of its foliage. They begin to appear upon the trees about the month of May, and continue until some time in September. Their power of reproduction is really wonderful, and were it not for some kinds of birds which feed upon them, they would soon be the means of entirely destroying many trees, and even plantations. They very often attack young plantations, and frequently confine themselves to one spot at a time; however, they are also found upon older trees, eating the young leaves in the same manner. There are several species of saw-flies injurious to vegetation, but the one which we have mentioned commits more mischief than any of the others. The larvæ of the saw-flies are easily distinguished from those of the moths by their feet numbering from ten to sixteen. The ovipositor of the female insect is used as a saw or file, with which she makes small holes in the branches for the purpose of depositing her eggs—hence the name saw-fly.

2173. *Cynips querci*, or the Oak-gall Fly.—The family *Cynipidæ* includes a number of peculiar insects, chiefly inhabiting the different species of oaks. They are all provided with a sting or ovipositor, which is entirely concealed except the extremity. With this instrument holes are bored in the leaves or small branches of the tree, and the eggs deposited in them, in much the same way as is done by the saw-fly. Some time afterwards, what are known as oak-galls are formed round the eggs, enclosing them in the centre, so that when the young larva is formed, it is in the middle of the gall, and remains there until it eats its way out, a perfect insect. The species which we mention is the one which is common upon our oak-trees, and is too well known to need any description from us here. It is found nearly all over the country wherever there are any oak plantations. Numbers of other gall insects infest the oak and other trees in a much similar way.

2174. *Sirex gigas*, or the Giant Sirex.—This is one of the pine-boring insects, and in some parts of the country becomes very destructive among coniferous trees. They are very large, and during flight make a humming noise. The following, taken from the 'Journal of Forestry,' will give an idea of this insect: "The specimens sent us are all females, and are easily distinguished from the males, being fully one-third larger, of a darker colour, and furnished on the under side of the abdomen, near the middle, with a strong black ovipositor, composed of two semi-cylindrical members with which it bores holes through the bark to deposit its eggs on the wood. The male is smaller, lighter in colour, and without the ovipositor, having a perfectly smooth cylindrical abdomen. After pairing, the female bores a hole for each egg in the bark of the stem of the tree with her long ovipositor. In about seven weeks after the eggs are laid, the larvæ have obtained their full size, and are from one and a half to two inches long; the tail-joint thick, ending in a short point; and of a whitish yellow colour. They then generally gnaw their way deep into the heart of the wood, forming a cavity at the depth of six inches, more or less, where they undergo transformation to the pupa state, covered with a thin transparent skin. In this state they remain for two years or longer; in fact, instances are on record of the perfect insect only making its appearance some years after the trees had been cut down, and the timber employed in house-building and other useful purposes." The trees which this insect seems to prefer are the Scots pine, spruce-fir, and one or two other conifers; and these are often found infested when in a decayed state, and even after being cut down. The insect is generally rare in this country, but where it does abound, it becomes a perfect nuisance. Another species (*Sirex juvencus*) is equally destructive to coniferous trees, working in the same way as *S. gigas.*

2175. Having now mentioned some of the most generally destructive of the many kinds of insects injurious to our forest-trees, we will conclude this section by giving a few hints as to the best way of preventing their attacks. Of course it must be understood that in many cases there are really no remedies, as up to the present time our knowledge of the actual habits of insects is too limited to be of much avail for this purpose. Until foresters are properly acquainted with the subject, they will be somewhat at sea in trying to prevent the attacks of injurious insects, and until then, only a few preventives can be applied. Our remarks will only refer to the best way of keeping woods and plantations as free from the attacks of insects as possible, and to any known remedy that can be properly used where they are numerous.

2176. It may be noticed here, that where the land is in a proper condition for the healthy growth of trees, and where the kinds are properly suited to the land, very little harm is found to arise from insect attacks on them. It is generally in wet and undrained districts that insects are engendered and numerous, and it is therefore in such that they are found to do most damage. On dry lands they are never found numerous in this country, and consequently, on such they are seldom or never found hurtful to trees, at least to anything like an important extent.

2177. *All dead branches*, and the *débris* of thinnings, should in all cases be removed from all plantations, and should, under no pretence, be allowed to lie upon the ground for any length of time after they are removed from the fallen trees. We too often have occasion to see in plantations fallen branches, and the remains of a course of thinning, left to rot upon the ground, without any attention being paid to gather them up or burn them. Such a system cannot be too much condemned, as it is opposed to all good taste and management; and not only so, but such dead and decaying branches are just the nurseries where most of the greatest insect enemies of forest-trees are bred and multiplied. By removing these branches, and either burning them or converting them into faggots for firewood, a great benefit to the plantation will be the result. By thus keeping all plantations free of rubbish of this kind, it will be found that they will not be liable to be infested with injurious insects. The after health of the growing crop will fully compensate for any expense that may be incurred in the operation of clearing and destroying the branches, even although the branches can be put to no profitable use. We would therefore advise all foresters who wish to have the woods under their charge in a good state of health, and as free from the ravages of insects as possible, by all means to have all *débris* cleared away as soon after thinning as possible.

2178. Where any of the beetles or moths may be got at, they should be picked off the trees and destroyed. This is no doubt a tedious and expensive process, but where the area infested is not large, it will be found that it is a sure remedy. A good plan is to use an averuncator, and cut off any small twigs that are covered with the insects or their larvæ.

2179. The Pine saw-fly has been destroyed by sprinkling naphtha upon the larvæ by a brush, and by this means we have seen them cleared from a plantation. For destroying those moths which bore into the trunks of the trees—for example, the leopard moth—the only way is to thrust a piece of sharp wire into the hole and pick out the caterpillar; or to blow tobacco smoke into the hole, which has the effect of disturbing the repose of the destroyer and bringing him out.

2180. Many cures have been tried in order to destroy these insects, but they are generally only applicable to single specimens, or to trees occupying a small area of ground. When a large plantation is infested, there is really no remedy but that of keeping the ground clear, and hand-picking as many of the caterpillars as possible.

2181. It should, however, be kept in view that all birds which feed upon insects should be preserved, as they materially assist in keeping down such vermin. Among the birds which are of use to the forester in this way, we may mention the chaffinch, goldfinch, greenfinch, woodpecker, titmouse, golden-crested regulus, wren, wagtail, cuckoo, starling, sparrow, flycatcher, robin, and some others. It will be to the forester's interest to preserve these, even although some of them show a special partiality for seeds.

SECTION VIII.—GAME INJURIOUS TO YOUNG TREES.

2182. It is a remarkable fact in the history of the rural economy of this country, that although partridges, pheasants, grouse, hares, rabbits, and deer are well known to be injurious to the interests of both landlord and tenant, they should be allowed in these times to exist, to the great loss of the community. The fact can only be accounted for on the principle that the landlords themselves are not yet sufficiently alive to their own interests in their land, nor to those the public have a right to expect at their hands as the proprietors of the country. The farmer, it is true, has now liberty to a certain extent to kill the ground-game on his farm, but so long as these animals are allowed to multiply in the woodland preserves surrounding his subject, he will derive but little benefit from such liberty. The loss to the country from these animals, in the department of forestry alone, must be very great, as on the greater number of extensive landed properties, large sums are annually expended in the replanting of enclosures which have had their crops less or more destroyed. We could give startling facts on the point; but as we have no wish to be personal in our remarks, but are merely desirous to point at the evil in a general way, we shall not refer to any case in particular. Landed proprietors, generally speaking, look upon their enclosed plantations as so many game preserves: and in reality they are so, as on most estates game lie quiet, and therefore breed there; and on most not even the forester himself is allowed to prosecute the necessary operations of thinning, for fear of disturbing the animals. The farmers in the neighbourhood of such woodland enclosures complain of the damage done to their crops, but although they are permitted to kill the ground-game on their fields, they dare not go into the enclosures to kill them, and from these the animals sally out upon the crops at all times, and when the attempt is made to kill them on the fields, they run back to their covers; and thus the poor farmer is surrounded by a host of enemies he dare not attack in their dens, and is ultimately obliged either to submit or to give up his farm. Let us now consider the point more in an arboricultural point of view. The forester plants an enclosure of some 50 acres. He thinks, as he proceeds with his work, that although there is a considerable quantity of game in the older enclosures, he has seldom seen much on the part he is about to plant. He encloses it, however; and no sooner is this done, than from its quietness it becomes the resort of hares and rabbits, which it was not before, while it was pastured and in the hands of a farmer. It is enclosed, however, and he must plant it. This he does; and not many months afterwards he finds the stems of his oak-trees stripped of their bark, and the tops of his larch eaten off—and this goes on day after day, while the forester looks on helplessly; for although he complain, his voice is not much attended to, because the gamekeeper protests that there are few hares, if any, in the enclosure, knowing that his employer is desirous he should have a good stock to shoot at when a day's sport is wanted by his master's friends. But we have said enough on this subject, and shall conclude by stating, that if these pests were altogether destroyed from the country, planting operations would not cost nearly so much as they generally do, and their results would be vastly more satisfactory.

CHAPTER XIX.

THE PERIODICAL INCREASE OF TIMBER IN THE DIFFERENT SPECIES OF FOREST-TREES.

2183. There is no part of a forester's education more neglected than that of having, as far as possible, a thorough knowledge of the size that trees ought to be, on a given soil and situation, at a given age. Such a knowledge can only be obtained by close observation and by extensive experience. For some years past, having been largely employed in the surveying and valuing of plantations, in England, Ireland, and Scotland, and seeing that there was great want of data upon which to calculate prospectively the future value of plantations, we have applied ourselves particularly to gain information upon this point, which we shall, in the present section, lay down for the guidance of others who may be called upon to act as valuators of wood. For a number of years past we have made it a point of duty, wherever we have been called upon to examine plantations, to take notes of the different sizes of trees as we found them to exist at a given age on a given situation; and having examined plantations of many kinds, upon a great variety of soils and situations, as well as under many descriptions of management, we have come to the conclusion that the size of a tree at a given age upon a given situation does not depend so much upon natural circumstances as upon the artificial management it may have received. In illustration of this, we may mention that we have surveyed plantations in England which were growing upon a very favourable soil and situation, and which, compared with others of a like age in Scotland, on a soil rather unfavourable, were, notwithstanding, far inferior to the latter,—this being occasioned by bad management in the one case, and good in the other. From such a case we may see that the cultivator of wood, as of any other product of the soil, has much in his power in making the crop profitable or not, even where natural circumstances may seem unfavourable.

2184. Well educated foresters on the continent of Europe, and especially those in Germany and France, have for a long time past made this branch of forestry a special study in their forest economy, and from this it follows that at the present time they are very much superior to British foresters in respect to arriving at the prospective value of any woodland crop. We refer to this point here, in order, if possible, to stir up *all foresters* to the systematic study of trees, in respect to the size each species ought to be on a given soil and situation, at a given age; as without such knowledge no man is capable of undertaking the management of extensive woods with anything like credit to himself or satisfaction to his employer.

2185. It would be impossible here to give the size which trees ought to attain on every variety of soil and situation, and under all circumstances of management—so much depending upon both artificial and natural local circumstances. For example, we have frequently seen a plantation of trees, which had been growing at a rapid rate, and making great progress in diameter of wood, suddenly checked in health by an over-thinning, and afterwards, in consequence, making but little progress; while, on the other hand, we have as frequently seen the trees in a plantation, which had been for a time in a confined state, and had been in consequence doing little, after being judiciously thinned, rapidly enlarge the diameter of their stems. Again, with regard to natural local circumstances, we have often observed trees growing on a situation much sheltered by older wood, &c., making great progress in the laying on of diameter of wood; while in another plantation not far distant, and upon the same description of soil and altitude, and under the same system of management as the other, but much more exposed to the free influence of the natural climate, trees of the same sort were making much less advance. In giving, therefore, our calculations in the present section as to the periodical increase of timber in trees, we beg to be understood that these are given as an average of what ought to be the result at certain ages, and under fair circumstances of situation and management.

2186. In taking our calculations of this periodical increase of timber, we have invariably measured the trees at about 8 feet from the ground; and, for the sake of better illustration, we have reduced our calculations to three distinct bases of situation. The first is an average of the periodical increase of timber in trees growing on a favourable soil and site; the second, of that increase in trees growing on moderately favourable ones; and the third is an average of the growth of trees growing on comparatively unfavourable ones.

2187. Having premised the above, we shall now give the periodical increase of the oak :—

Ages of Trees.	Diameter in inches eight feet from the ground.		
	1st. On favourable Soil and Site.	2d. On moderately favourable Soil and Site.	3d. On unfavourable Soil and Site.
Oak at 10 years old, . .	1¼	¾	¼
" 20 " . .	4½	3	2
" 30 " . .	9½	7	4½
" 40 " . .	16	12½	8
" 50 " . .	20½	16	9
" 60 " . .	25½	18	10
" 70 " . .	29	19½	11
" 80 " . .	31½	20½	11½
" 90 " . .	32¾	21½	...
" 100 " . .	33½	22	...
" 120 " . .	34¾	...	...

2188. The foregoing statements relative to the oak have all been taken in cutting down timber at all the different ages specified; and the numbers given under each head are the averages taken from many trees of the same age. The most prominent feature of the statement is, that upon the favourable soil and situation, as stated under the 1st division, the oak not only grows more rapidly and attains a greater diameter of wood in a given number of years, but it also continues to grow healthily, and lay on a greater bulk of wood at a great age, than the others on less favourable soils and situations—that is, taking the oak upon a favourable soil and site, at from 90 to 100 years of age, we will invariably find it make considerable progress during that period; while the same sort of trees, as found growing upon a less favourable soil and site, will have almost ceased to make any perceptible amount of timber. Between 90 and 120 years of age, the tree, in the former case, has increased its diameter to the extent of 2 inches; while in the latter, one ½ inch is made during that period of 30 years; and again, in the third case specified, no increase has been made at all, and at this stage the wood of such a tree must be in a declining state. We thus see that, on an unfavourable soil and site, if we wish to have the wood in its most valuable state, it should be cut between 60 and 70 years of age, and on the moderately favourable soil between 80 and 90; while upon the favourable soil it may be left growing till perhaps 140 or 150 years. At first sight it may appear that 2 inches in diameter is but a small amount of wood to be laid on by a tree during a period of 30 years, as in the case of the oak in the 1st class between 90 and 120 years. But if we suppose the stem of such a tree to be 20 feet long only, we will have laid on during that period at least 14 feet of extra timber, which, at 3s. per foot, gives £2, 2s. of additional value in wood laid on.

2189. We shall now proceed with a corresponding statement relative to the larch; but instead of giving the diameter at periods of 10 years, as in the case of the oak, we shall take periods of 5 years. Our reason for doing so is that, in cutting down larch trees, their periodical thinnings are generally made at or within periods of 5 years; consequently it is an object of importance to have an estimate of the diameter which they should, in general cases, present at periods of 5 years.

AGES OF TREES.	DIAMETER IN INCHES EIGHT FEET FROM THE GROUND.		
	1st. On favourable Soil and Site.	2d. On moderately favourable Soil and Site.	3d. On unfavourable Soil and Site.
Larch at 10 years old, . .	2½	1¼	...
" 15 " . .	5	3	2
" 20 " . .	9	7	5
" 25 " . .	11	9	6
" 30 " . .	13½	11	7½
" 35 " . .	17	13½	8
" 40 " . .	22	15½	...
" 45 " . .	23½	16½	...
" 50 " . .	24½	17	...
" 55 " . .	25½	17½	...
" 60 " . .	27	18	...
" 65 " . .	28	...	...
" 70 " . .	29	...	...
" 75 " . .	30	...	...
" 80 " . .	30½	...	...

All those measurements are taken from trees cut down upon the estate of Arniston. They indicate to us that, on a favourable soil and site, the larch will continue to make wood till above 80 years of age, and will even then be of a sound constitution, as we have frequently had occasion to observe; while, on a soil of moderate capabilities, 60 years of age may be considered as the maximum of the larch; and in order to have the full value of the trees growing under such circumstances, they should then be cut down. Again, upon a soil and situation unfavourable, from 30 to 35 years may be considered as the maximum of the trees; and if not cut down at that age, the trees will begin to decay rapidly in the heart-wood.

2190. We shall next give a statement of the progressive growth of the Scots pine, as taken from specimens of the tree measured in the Highlands of Scotland, as well as others on several other properties in the north.

Ages of Trees.	Diameter in inches eight feet above the ground.		
	1st. On favourable Soil and Site	2d. On moderately favourable Soil and Site.	3d. On unfavourable Soil and Site.
Scots pine at 10 years old, .	1¾	1	...
” 15 ” .	4½	3	½
” 20 ” .	6½	4½	2½
” 25 ” .	10	6	4
” 30 ” .	12	7½	5½
” 35 ” .	14	9	6
” 40 ” .	16	10½	6½
” 45 ” .	17½	12	7
” 50 ” .	19	13½	7¼
” 55 ” .	20½	14½	...
” 60 ” .	21½	15½	...
” 65 ” .	22½	16½	...
” 70 ” .	23¼	17	...
” 75 ” .	24	17½	...
” 80 ” .	24½	18	...
” 85 ” .	25	...	...
” 90 ” .	25¼	...	...
” 95 ” .	26	...	...

2191. The following represents the periodical increase of timber in the spruce fir, as taken from an average of trees measured on a number of estates in Mid-Lothian:—

Ages of Trees.	Diameter in inches eight feet above the ground.		
	1st. On favourable Soil and Site.	2d. On moderately favourable Soil and Site.	3d. On unfavourable Soil and Site.
Spruce fir at 10 years old, .	2¾	1¼	...
” 15 ” .	5	3	1½
” 20 ” .	7	5½	3¼
” 25 ” .	10	8	4½
” 30 ” .	13½	11	5½
” 35 ” .	15	13	6
” 40 ” .	17½	15	...
” 45 ” .	18¾	16	...
” 50 ” .	20	17½	...
” 55 ” .	21¼	18	...
” 60 ” .	22¾	18¼	...
” 65 ” .	23½	18¾	...
” 70 ” .	24½	19	...
” 75 ” .	25½	...	...
” 80 ” .	26¼	...	...
” 85 ” .	27	...	...
” 90 ” .	27¾	...	...

The measurements in the 1st class of spruce firs, as above stated, were taken from trees generally growing in hollow sheltered parts upon a stiff heavy clay of a damp tenacious nature; and those in the 2d from trees generally growing upon a fair loamy soil on flat parts of the country, well drained. Those in the 3d class, being upon unfavourable soil and situation, have all been taken from the average of trees found growing upon a thin gravelly soil with a high exposure, under which circumstances the spruce seldom arrives at any useful size, generally taking heart-rot when from 30 to 35 years of age, and then failing to make wood, as indicated in the table.

2192. The following statements show the periodical increase in the ash and sycamore, taken from measurements of trees cut down on the estate of Arniston, as well as upon some other estates in Mid-Lothian—all of which were, we consider, growing under moderately favourable circumstances of soil and situation. Not having got measurements upon 1st or 3d class ash and sycamore trees, we must in the mean time restrict ourselves with regard to these trees to the average of 2d class ones:—

AGES OF TREES.	DIAMETER IN INCHES EIGHT FEET ABOVE THE GROUND		AGES OF TREES.	DIAMETER IN INCHES EIGHT FEET ABOVE THE GROUND	
	The Sycamore, on a moderately favourable Soil and Site.	The Ash, on a moderately favourable Soil and Site.		The Sycamore, on a moderately favourable Soil and Site.	The Ash, on a moderately favourable Soil and Site.
At 10 years old,	2¼	1½	At 70 years old,	22½	24
„ 20 „	5½	4½	„ 75 „	23½	26
„ 30 „	9½	7	„ 80 „	25½	28
„ 35 „	11½	9	„ 85 „	27½	30
„ 40 „	13	10½	„ 90 „	29	31½
„ 45 „	15	12	„ 95 „	30	33
„ 50 „	16½	14½	„ 100 „	31½	34
„ 55 „	18	17	„ 105 „	33	34½
„ 60 „	19½	19½	„ 110 „	34	...
„ 65 „	21	22			

2193. We shall now give a statement of the periodical increase of timber in the Scots elm and the black poplar. The elm is an average of trees growing upon a moderately favourable soil and situation, and the poplar of those raised in a very favourable one. As yet we have not had leisure to devote such time to the subject as to enable us to furnish data to give statements of the 1st and 3d class trees of the elm, or of the 2d and 3d of the poplar. In the mean time, therefore, we defer giving any more than the following, hoping that still it may be in our power to supply those particulars which are now left blank:—

Ages of Trees.	Diameter in inches eight feet above the ground.		Ages of Trees.	Diameter in inches eight feet above the ground.	
	Black Poplar, on a favourable Soil and Site.	The Scots Elm, on a moderately favourable Soil and Site.		Black Poplar, on a favourable Soil and Site.	The Scots Elm, on a moderately favourable Soil and Site.
At 10 years old,	6	1½	At 55 years old,	42	19
„ 15 „	10	4	„ 60 „	43	21
„ 20 „	15	6	„ 65 „	...	22½
„ 25 „	21	8½	„ 70 „	...	23½
„ 30 „	26	10	„ 75 „	...	24½
„ 35 „	29½	12½	„ 80 „	...	25½
„ 40 „	33	14½	„ 85 „	...	26
„ 45 „	36½	16	„ 90 „	...	27
„ 50 „	39½	17½	„ 100 „	...	28

2194. We shall now give the beech and sweet chestnut, as taken from the average of a number of trees cut down in various estates in Mid-Lothian, on moderately favourable soils and situations.

Ages of Trees.	Diameter in inches eight feet above the ground.		Ages of Trees.	Diameter in inches eight feet above the ground.	
	Sweet Chestnut, on a moderately favourable Soil and Site.	Beech, on a moderately favourable Soil and Site.		Sweet Chestnut, on a moderately favourable Soil.	Beech, on a moderately favourable Soil and Site.
At 10 years old,	2½	2	At 50 years old,	15	21
„ 15 „	4½	4	„ 55 „	16½	22½
„ 20 „	7	6½	„ 60 „	17½	24
„ 25 „	8½	9	„ 65 „	19	25½
„ 30 „	10	10½	„ 70 „	20	27⅓
„ 35 „	11½	15	„ 75 „	21	28¼
„ 40 „	13½	17	„ 80 „	22	29
„ 45 „	14½	19½	„ 85 „	22½	30½

From the two statements given above relative to the periodical increase of timber in the sweet chestnut and the beech, it is very observable that, on a soil of moderate capabilities, the beech grows to a much larger size than the sweet chestnut; showing that, in order to bring the sweet chestnut to the larger dimensions which we find in some parts of the country, it requires a favourable soil and situation—a point of great importance to be kept in view by any person engaged in valuing wood for the transfer of property.

2195. We shall next give a statement as to the common silver fir and birch, as taken from the average of a large number of trees of both kinds felled on the Bute estate, on moderately favourable soils and situations:—

Ages of Trees.	Diameter in inches eight feet above the ground.		Ages of Trees.	Diameter in inches eight feet above the ground.	
	Silver Fir.	Birch.		Silver Fir.	Birch.
At 10 years old,	1½	½	At 80 years old,	30	15
„ 20 „	8	2½	„ 90 „	32	15
„ 30 „	12¾	7	„ 100 „	33¾	...
„ 40 „	15¾	10	„ 110 „	36½	...
„ 50 „	18	12	„ 120 „	37¾	...
„ 60 „	24	14			
„ 70 „	28½	14½			

From this statement it is brought out that the common silver fir, when grown on a moderately favourable soil and situation, and when of 10 years' standing, is fully larger in the diameter of its stem than the spruce fir is under similar circumstances—the latter, at 8 feet up, being only 1 inch in diameter, while the former is 1½ inch at the same height. The rapid growth of the silver fir is very observable between 10 and 20 years, and even up to 60, when, on even moderate soil, its diameter exceeds that of the spruce fir at the same age, even when the spruce is found growing on favourable soils and sites. Another remarkable feature in the silver fir is, that it continues to grow and lay on timber to a much greater age than the spruce fir does—the latter almost ceasing to increase in diameter after it has attained the age of from 80 to 85 years, while the former grows and adds considerable layers of wood even up to 110 years. With reference to the birch, it is enough to remark that it seems to grow very little after it has attained 70 years of age.

2196. Having now given the foregoing statements relative to the periodical growth of our principal forest-trees, in so far as our observations on the subject will at present permit us to do in a decided manner, we shall only state, in conclusion upon this point, that we have found these calculations of the greatest value to ourselves when called out to value plantations prospectively for the transfer of landed property; and we have no doubt but that they will also prove of value to others. There is great want of a far more extensive basis upon which to calculate the progressive growth of trees than is here given; and it would be of infinite advantage to all interested in timber-growing, were every intelligent forester to turn his attention to this point, and lay up, at least for himself, from his own experience, as extensive data as possible relative to the periodical increase in the growth of timber on the estate upon which he may be employed.

SECTION II.—THE PERIODICAL INCREASE OF HEIGHT IN THE DIFFERENT SPECIES OF FOREST-TREES.

2197. During the last ten years we have had many inquiries from landed proprietors and others as to what height a tree of a given species should be at a given age, and from these inquiries we have devoted considerable attention to the subject for some time past, in order to be enabled to give the desired information in this edition of our work. In attending to this, we have taken measurements of the lengths of trees of the various kinds usually grown in our plantations, as these were cut down as thinnings, at the ages of 10, 15, 20, 25, 30, 35, and 40 years; and the results of these measurements are given in the following statements. It must be understood, however, that the heights stated in respect to each species are the results of many averages, as in no other way can a fair statement of height be given in respect to trees growing in plantations. For example, taking the larch at 10 years of age, we have found in some plantations trees measuring 28 feet 6 inches in height; in others, we have found them about 20 feet; while in others we have found them only about 12 feet in height. Therefore in our statements respectively, we give the average of the height of many trees of the same species, at the different ages stated; and having premised the above, the reader will the better understand the nature of the following statement in respect to the heights of the different species of our forest-trees.

2198. The following statement shows the periodical increase of height in the lime tree and sycamore, as brought out from measurements of trees of these sorts thinned from various plantations in Yorkshire:—

Ages of Trees.	The Lime Tree.			The Sycamore.		
	Heights in feet and inches.		Average annual increase of height at 40 years.	Heights in feet and inches.		Average annual increase of height at 40 years.
	ft.	in.		ft.	in.	
At 10 years old, . .	15	8	...	18	6	...
„ 15 „ . .	22	0	...	26	6	...
„ 20 „ . .	28	0	...	34	0	...
„ 25 „ . .	34	0	...	40	0	...
„ 30 „ . .	40	0	...	44	10	...
„ 35 „ . .	44	6	...	49	0	...
„ 40 „ . .	49	0	14½ in.	53	10	16 in.

2199. We shall next give a statement as to the periodical increase of height in the Spanish and horse chestnuts—the measurements of these being also taken from trees thinned from plantations in Yorkshire:—

Ages of Trees.	The Spanish Chestnut.			The Horse-Chestnut.		
	Heights in feet and inches.		Average annual increase of height at 40 years.	Heights in feet and inches.		Average annual increase of height at 40 years.
	ft.	in.		ft.	in.	
At 10 years old, . .	18	9	...	19	0	...
„ 15 „ . .	25	0	...	27	0	...
„ 20 „ . .	32	0	...	33	0	...
„ 25 „ . .	38	0	...	37	9	...
„ 30 „ . .	42	0	...	41	6	...
„ 35 „ . .	46	6	...	44	0	...
„ 40 „ . .	49	8	15 in. nearly	47	0	14 inches

2200. The following statement shows the periodical increase of height in the ash and the wych elm, as taken from measurements of trees thinned from plantations in the county of Fife:—

Ages of Trees.	The Ash.			The Wych Elm.		
	Heights in feet and inches.		Average annual increase of height at 40 years.	Heights in feet and inches.		Average annual increase of height at 40 years.
	ft.	in.		ft.	in.	
At 10 years old, . .	20	0	...	16	8	...
„ 15 „ . .	28	10	...	25	0	...
„ 20 „ . .	35	10	...	33	0	...
„ 25 „ . .	43	0	...	40	6	...
„ 30 „ . .	50	0	...	47	0	...
„ 35 „ . .	55	9	...	52	6	...
„ 40 „ . .	61	0	18 in. nearly	56	0	16¾ inches

2201. We shall next give a statement as to the periodical increase of height in the oak and beech, as taken from measurements of trees thinned from plantations in Shropshire:—

Ages of Trees.	The Oak.			The Beech.		
	Heights in feet and inches.		Average annual increase of height at 40 years.	Heights in feet and inches.		Average annual increase of height at 40 years.
	ft.	in.		ft.	in.	
At 10 years old, . .	14	0	...	11	6	...
„ 15 „ . .	20	6	...	17	10	...
„ 20 „ . .	27	0	...	24	0	...
„ 25 „ . .	33	0	...	29	10	...
„ 30 „ . .	39	0	...	35	8	...
„ 35 „ . .	44	7	...	41	0	...
„ 40 „ . .	47	6	14¼ inches	46	6	14 in. nearly

2202. We have now to give a statement of the periodical increase of height in the Black Italian Poplar and the *Abies Douglasii*, as taken from measurements of trees of these sorts standing alone in various parts of England and Scotland:—

Ages of Trees.	Black Italian Poplar.			Abies Douglasii.		
	Heights in feet and inches.		Average annual increase of height at 40 years.	Heights in feet and inches.		Average annual increase of height at 80 years.
	ft.	in.		ft.	in.	
At 10 years old, . .	29	10	...	24	10	...
„ 15 „ . .	43	0	...	36	8	...
„ 20 „ . .	56	10	...	49	6	...
„ 25 „ . .	68	0	...	60	9	...
„ 30 „ . .	75	11	...	71	0	28 in. nearly
„ 35 „ . .	81	6	...	Have not had opportunities of measuring specimens of this tree at 35 and 40 years of age.		...
„ 40 „ . .	86	8	26 inches			...

2203. Next in order, we shall give a statement as to the periodical increase of height in the larch and Scots pine, taken from measurements of these kinds of trees felled as thinnings in various parts of the west of Scotland, and on estates where both kinds were found healthy and promising:—

Ages of Trees.	The Larch.			The Scots Pine.		
	Heights in feet and inches.		Average annual increase of height at 40 years.	Heights in feet and inches.		Average annual increase of height at 40 years.
	ft.	in.		ft.	in.	
At 10 years old, . .	18	6	...	17	0	...
„ 15 „ . .	26	8	...	24	8	...
„ 20 „ . .	34	8	...	33	0	...
„ 25 „ . .	43	10	...	41	6	...
„ 30 „ . .	49	0	...	47	6	...
„ 35 „ . .	54	9	...	54	0	...
„ 40 „ . .	58	7	17½ inches	59	7	17¾ inches

2204. In conclusion, on the subject of this section, we shall give a statement as to the periodical increase of height in the common silver fir and the Norway spruce fir, the measurements of which are taken from trees thinned from plantations in the West Highlands of Scotland:—

Ages of Trees.	Common Silver Fir.			Norway Spruce Fir.		
	Heights in feet and inches.		Average annual increase of height at 40 years.	Heights in feet and inches.		Average annual increase of height at 40 years.
	ft.	in.		ft.	in.	
At 10 years old, . .	12	6	...	20	0	...
„ 15 „ . .	23	10	...	28	6	...
„ 20 „ . .	34	10	...	37	6	...
„ 25 „ . .	44	0	...	46	6	...
„ 30 „ . .	53	8	...	54	8	...
„ 35 „ . .	62	0	...	61	0	...
„ 40 „ . .	68	10	20½ inches	66	0	19¾ inches

2205. Having given the foregoing statements as to the periodical increase of height in the common species of our forest-trees, we think it unnecessary to make any particular remarks on the subject. We may state, however, that we have not as yet had opportunities of taking measurements of the heights of trees above 40 years of age, and that, therefore, we must defer giving statements as to the heights of trees of a greater age than 40 years till we shall have had opportunities of thinning such, and to an extent sufficient to enable us to get fair averages taken of the different species.

SECTION III.—THE GROWTH OF TREES IN DIFFERENT YEARS.

2206. It is now a well-ascertained fact that the growth of trees, both in respect to their increase in height and to the depth of new wood laid on their stems, is not alike in every year. We have had many opportunities of observing this in all our common kinds of trees while thinning plantations, and have taken notes accordingly, which lead us to the conclusion that the differences found in the growth of trees in different years represent a record of the influences of the seasons upon the growth of trees.

2207. Taking a transverse section of a tree of some considerable age, it will be found that in one particular year the layer of new wood will measure nearly ⅜th of an inch in depth, and that the next layer above it will not measure over ¼th of an inch, while the one outside of this may not be much over ⅛th of an inch, and so on, very few of the annual layers being found alike in any tree.

2208. Similar differences occur in the annual growths of the branches lengthwise, and in those of the tops upwards. In cutting down trees as thinnings from plantations in perfect health, we have remarked that the top growths of most of the trees felled were, at the time we operated on them, from 18 to 22 inches in length, while those of the previous year measured only from 12 to 18 inches; and in examining the subjects in the whole length of their stems, we found that proportionate differences in the growth of the stems lengthwise had taken place in previous years as well. Such differences as these will be found in the growth of trees in all plantations, and can be accounted for only on the principle that seasons which are very favourable for the growth of wood give rise to a great degree of vitality in trees, and consequently to their laying on a large amount of woody matter, while seasons of an opposite character have a tendency to lessen the vitality of trees, and therefore the amount of woody matter they lay on is lessened accordingly.

2209. All kinds of trees are not affected alike in the same season, however, as it will be found that, generally speaking, the deciduous sorts make their greatest growths in dry seasons, while the spruce and silver firs make their greatest growths in seasons that are generally of a wet character; and, on the other hand, the larch and pines invariably make their greatest growths in seasons of a moderate character. And we may add that, in very dry seasons, the spruce and silver firs make comparatively small growth, and are sometimes even killed if they are not on a soil of a cool-bottomed nature.

CHAPTER XX.

HOW TO FIND THE VALUE OF GROWING PLANTATIONS, AND OF FULL-GROWN TIMBER TREES.

2210. The valuing of plantations is a point of forestry which, to be done properly and justly, requires the exercise of the judgment of a man who has had long practical experience in the matter. He who gives himself out as a valuator of plantations, in the settlements and divisions of landed property, must be possessed of an accurate knowledge of the prospective value of all the plantations that can possibly come under his notice, under the age of full-grown timber. He must have an intimate knowledge of the habits of growth of the different species of forest-trees, and of the influence of soil and local climate on their periodical increase of timber,—these qualifications being absolutely necessary in the valuing of young plantations while they are under the age of full-grown timber trees; and as such qualifications are only attainable by a pretty long course of experience as a practical forester, we shall here state only the general method of going to work in valuing plantations.

2211. In taking the present transferable value of plantations, they are divided into three different and distinct classes, namely:—

1st, Plantations not thinned for the first time.

2d, Those which have been thinned, but are under full-timber size.

3d, Those of full-timber size.

As each of these classes is valued in a manner different from the others, we shall here treat of the manner of valuing in each case separately. With regard to the first, then: were we called upon to give the transferable value of any young plantation which had not been thinned for the first time when we saw it, we would in the first place calculate the original expense of fencing, draining, and planting; and having ascertained this point, we would next measure the extent of the plantation in acres, and put upon it a rent per acre, corresponding with the same quality and condition of land in the immediate neighbourhood, but in all cases making an allowance for inaccessible heights and hollows. Then the rule for finding the valuation is—to the cost of fencing, draining, and planting, and the rent of the land occupied for the time, add the amount of compound interest on these, at from 3 to 5 per cent, according to the state of the crop, and the result will be a fair transferable value between the two parties.

2212. With regard to the second class of plantations mentioned above—namely, those which have been thinned, but are under full-timber size:—

When trees attain a size when it is necessary to thin them for the first time, they will then afford certain evidences on which to found calculations of their ultimate produce and value. Therefore, at the time when young trees show evidence of their future health, and until they have attained a full-timber size, the valuation of such plantations ought to proceed on the principle of prospective value, and the rule for doing so is this:—First, determine the number of years the trees will require to arrive at maturity; second, calculate the clear value of all thinnings that are likely to be taken from the plantation before it arrives at maturity, and that in periodical thinnings of 5 years from the time that the valuation is taken; and third, estimate the value of all the trees which will arrive at perfection of growth: from the total amount of these sums deduct compound interest for the period the trees require to attain maturity, and the result will be the present transferable value of the plantation. Although this may be said to be the general rule for valuing plantations of the class under notice, still, in practice, it very frequently requires to be modified to adapt it to the particular circumstances of cases; which circumstances and cases can be distinguished, and the modifications applied, only by the man of sound judgment and large experience in such matters, according to the nature of the subject he may have to deal with at the time.

2213. With regard to the third class of plantations as above stated —namely, those which have arrived at full-timber size:—

As this is a class of plantations which every forester ought to be able to value at sight, we shall be more particular in pointing out the method of going to work here. Few foresters are ever called upon to value the two first-named classes of plantations, but the case is altogether different with regard to full-grown trees: these are the harvest of their labours, and they are almost every day called upon to cut down and value trees of full-grown dimensions. In this case it is not the transferable value of the unripe crop as found upon the land that we have to do with: it is the simple value of the wood itself—the value of each tree in its perfect state, in so far as the ground is qualified to produce it.

2214. It is often necessary that full-grown timber trees should be valued previous to their being cut down; and particularly in the case of a transfer of property, it is absolutely necessary to have this done, inasmuch as the trees are a part of the property to be sold. In taking the value of timber in its growing state, two methods are in practice among wood-valuators: the one is to measure the height of each tree by means of a measuring-pole with a ladder, and by actually girthing the tree in the middle with a cord, and finding the contents in the usual manner of measuring round timber; the other method is, that of judging by the eye the number of feet that each tree may contain.

2215. With regard to the first method—namely, that of measuring the trees by means of a pole with a ladder—some suppose that this is the more correct way of going to work in the valuation of growing timber; and in consequence of this opinion having for some time past prevailed among the older class of valuators, much precious time has been lost by them, as well as useless expense entailed upon the proprietors who have employed them. From the many obstacles that are apt to come in the way, it is almost impossible to measure correctly any large tree in its growing state; and by a short sketch of the manner of proceeding in this kind of work, the obstacles to correctness will at once appear. In measuring trees thus, the valuator has with him two men—the one carrying with him a pretty long ladder, in order to get upon the trees from the ground; while the other bears with him a measuring-pole, generally about 10 feet in length, divided into feet and inches for measuring the height of the tree, and a tape-line marked with feet and inches for taking its girth. With these assistants thus furnished, the valuator proceeds by causing the man with the ladder to hold it to a tree, while the other goes upon it, and with his rod measures the height of the tree as he proceeds upwards. Having ascertained the entire height, as far as may be considered measurable timber, he again measures downwards, one-half of the height of the tree, in order to take the girth at that part, for calculating the side of the square: and in this manner the valuator proceeds from one tree to another, noting down the dimensions as he proceeds. Now, as to correctness, this method would do very well, provided that there were no branches upon the trees—and, no doubt, the operators always choose that side of a tree which is most free from branches; but, notwithstanding, there are few trees which, in taking a straight line from top to bottom, have not several branches to intercept the object. This is what makes their measurement so very incorrect; for when the man with the pole has his line of measurement intercepted by one or two branches, he generally has to change his position upon the tree, and this often many times in the ascent of one tree,—often causing, consequently, an error of several feet in the value of one tree, less or more. Intelligent valuators of the present day, in all cases, accustom themselves to estimate any standing tree simply by sight — which is, indeed, when done by an experienced man, the method most to be depended upon. The eye is not easily deceived in the comparative magnitude of any two or more objects—and more particularly, if it has been long accustomed to compare the relative sizes of different objects of the same form, its judgment, if we may so speak, becomes almost indisputable; at least, a man is very seldom deceived by his eyes in the viewing of an object, if he have but accustomed them to act in accordance with his judgment—and this is all that is required in order to give a correct idea of the size of any tree. It merely requires that the eye should be accustomed to the work, and that judgment should never be passed on the size of a tree until the mind is actually satisfied of the truth of the impression produced.

2216. Every forester ought at once to be able to estimate the size of any tree on first sight of it. But a course of training is necessary before being able to do this; and as we, in all cases of valuing growing timber, pass judgment of the size simply by sight, we shall here point out the course of training necessary to those who may wish to excel in this most useful point in forestry.

Those who never have accustomed their eyes to compare the relative sizes of different objects, may at first be led to think that it is impossible for any man to give a correct judgment of the exact bulk of one tree as compared with another. This opinion at first sight is natural, but the power of habit is well known to be incredible; and those who entertain the idea of there being great difficulty to overcome, may be assured that a few weeks of persevering practice will overcome all the difficulty. When we first commenced training ourselves to value trees by sight, we were engaged in the thinning of plantations from 20 to 40 years old. For a few weeks we, in every case of cutting down a tree, first eyed it from bottom to top, and from top to bottom, and passed our judgment as to the number of cubic feet it contained before we cut it down; and as soon as we had the tree cut down and pruned, we measured the length with our rule, and took the girth in the middle, and, on casting up the contents, we compared the result with our previous judgment of the matter; and at the end of three weeks—which time we were employed in the thinning of the plantations mentioned—we could have told to within a mere trifle the actual number of feet and inches in any individual tree before we cut it down. In the same manner we practised ourselves when cutting down large trees, embracing every opportunity of improving our judgment upon the point, until we came to have perfect confidence as to the correctness of our decision.

2217. But there is one remark which may be useful to mention here, relative to the correctness or incorrectness of the judgment of the eye in taking the size of a tree—namely, the mind must be perfectly at ease. A valuator with his mind uneasy upon any point foreign from his present purpose, is certain to commit errors; and this we mention in order that any young beginner who may read this, and may commence his training in the way we did, may be upon his guard at all times when valuing.

2218. Having thus pointed out the way by which any forester may acquire the useful habit of valuing trees by sight, we shall now give a statement of the manner in which we generally go to work in the actual valuation of the trees in a plantation.

When called upon to take the valuation of a plantation of full-grown trees, or, as it may be, a thinning of trees from a plantation, we provide ourselves with a pretty large passbook, containing, as usual, money columns on the right-hand side of each page, and the spaces on the left-hand side of the money columns we divide into four equal parts, parallel with them. The first space on the left-hand side is for entering the numbers to correspond with those intended to be marked upon the trees; the second, for entering the species of each tree as it is numbered; the third, for entering the number of cubic feet contained in the tree as marked; and the fourth contains the price per cubic foot of each tree as numbered. The following sketch of this form of book will more readily assist the learner:—

2219.

Number of each Tree.	Species of each Tree.	Cubic feet in each Tree.	Price per Foot of each Tree.		Value.		
			s.	d.	£	s.	d.
1	Oak	90	3	6	15	15	0
2	Do.	30	2	6	3	15	0
3	Ash	82	2	0	8	4	0
4	Do.	20	1	6	1	10	0
5	Elm	73	2	0	7	6	0
6	Do.	30	1	8	2	10	0
7	Beech	75	1	6	5	12	6
8	Do.	25	0	10	1	0	10
9	Plane	87	3	0	13	1	0
10	Do.	26	1	6	1	19	0
11	Larch	64	2	0	6	8	0
12	Do.	32	1	4	2	2	8
13	Scots Fir	58	1	6	4	7	0
14	Do.	18	1	0	0	18	0

2220. In the act of valuing trees in the forest, we do not of course take time to sum up the value of each tree, but leave the money columns blank until we have the work finished, or at least until the evenings when we get home, when we have leisure to do so correctly. Having provided ourselves with a book of the description mentioned above, all ready and ruled, with the numbers filled in, and the uses of the columns written along the top of each page, we next engage three men of active habit, each provided with an *iron* adapted for the marking of figures upon the bark of trees: one of the men begins by marking No. 1 upon the first tree to be valued, a second man marks No. 2, and a third No. 3; and in this manner the three men follow one another, each of them marking his own number next in succession upon another new tree—that is, if the first man mark No. 1, his next in succession will be No. 4; if the second mark No. 2, his next will be No. 5; and so on with the rest. When the men are properly arranged at their work of marking the trees, we next commence ourselves with the tree having the mark No. 1 upon it, and write opposite the same number in our book the species of the tree; next, the number of cubic feet that we think it contains; and lastly, the price per cubic foot of each tree, such as we think it would really bring in the market at the time of valuation. In the same manner we go on with every tree to be valued.

2221. We may remark here that every valuator of growing timber, previous to entering upon the valuation of it in any locality with which he is not well acquainted, should in all cases make himself properly aware of the general prices of wood in that district; for if he do not, he will unquestionably commit gross errors in his work. If, for instance, a valuator were to be called from Edinburgh to value wood in any inland district, from which it had to be carried a long way to market, and he proceeded to value the same according to the rate of wood-sales in the neighbourhood of Edinburgh, his valuation would of course be much too high, because in any inland district there is comparatively little local demand for wood; consequently, before the wood could be sold, it would require to be carted by the purchaser a considerable distance to some railway station before it could be taken to a market; and seeing this, the valuator should always regulate his prices according to the prices that he knows will be given at the nearest market, deducting the expenses which will be necessary to carry the timber between the place where it is growing and the market where it is to be sold.

CHAPTER XXI.

SECTION I.—EFFECTS OF TRANSPLANTING ON THE CONSTITUTION OF TREES.

2222. For many years past, the transplanting of large trees from the forest ground to the park, with the view of producing an immediate effect where these were wanting upon the home grounds of proprietors, has been practised with more or less success, and that in proportion as the operation of removing the trees had been done in the manner least tending to check the healthy flow of vegetable life in the trees so removed.

It appears very evident to us that any tree, however large it may be, if only in a healthy and growing state, may, under certain circumstances, be as safely removed from one position to another as the merest sapling from the nursery-bed. If we can, in our everyday practice, calculate on the certainty of a small oak-tree growing when it has been removed from the nursery-row to the open forest-land, may we not, with equal certainty, calculate upon a large oak-tree growing, when merely removed from one part of a landed property to another, provided the operation, in the case of the large tree, be performed with that amount of care and skill which is necessary to preserve in healthy action all its life principles?

2223. We are aware that many entertain opinions, relative to the transplanting of large trees, very different from ours as expressed above; and those who differ from us as to the propriety and practicability of safely transplanting large forest-trees, say that the constitution of a young tree is more pliable and not so easily injured as that of a large one, and consequently is not so easily affected by sudden change or removal. This, no doubt, is true; but if we, in the removal of a large tree, can but adjust the operation to the natural wants and requirements of the subject handled in the same proportion as we can do to the smaller one, are we not, according to the usual laws of nature as found to exist in all plants, equally entitled to say that the one will continue in health as well as the other? There can, we think, be no dispute as to that; therefore, in the transplanting of all trees, whether young or old, large or small, all that is required in the operator is, *to adjust that operation to the natural wants and requirements of the subject*, when the success will be as complete in any one case as in another.

2224. Those who maintain that success in the transplanting of large trees cannot be obtained in equal proportion as in the case of young ones, point to the many failures that have taken place in that department of arboriculture, on, undoubtedly, very many landed properties in Britain—saying, at the same time, that a great deal of money has been uselessly expended by proprietors upon that operation, who have had nothing but disappointment as their reward in the end. This we must also admit. But the grand question is, Were those trees which failed to grow according to the expectations of the proprietors who so laudably endeavoured to ornament their estates, and which cost them so much labour to little purpose, transplanted in such a manner as to fulfil the conditions we have specified? We fear not. Wherever this rule has not been attended to in times past, disappointment has been the result; and wherever it shall not be attended to in future, disappointment will also follow as the natural consequence. Having premised the above, we shall now endeavour to point out the cause of disappointment where that has taken place in the transplanting of large trees.

2225. It is not to be wondered at that many of the cases of transplanting large trees, hitherto performed, have failed of that degree of success which was expected as the result, seeing that few of them have been conducted upon principles consistent with the ordinary laws which are known to maintain a healthy state of vegetable life. Every tree of any considerable size has its principal feeding roots situated, for the most part, at the greater distance from its stem; consequently, in the case of removing a large tree from its original site, those must necessarily be cut off, and cannot act as absorbents of nourishment for the parent stem afterwards. Keeping this in view, then, is it anything remarkable that we find a tree dying after it has been separated from its means of deriving nourishment from the earth? Such a result is quite in accordance with the laws of nature as found to act upon vegetable life; and this has exactly been the state of things relative to those large trees which, after having been transplanted, either died suddenly or lived a few years in a languid and sickly state, and that just in proportion as they might have had less or more healthy fibrous roots left upon them at the time of removal.

2226. We have not unfrequently seen trees of a considerable size lifted from their original site and transplanted into another, where they were expected to succeed well; and yet they had been, as it were, torn from the soil, and all their roots left in it, little or no precaution having been used to retain them. In such cases, the soil was removed from all the roots to a considerable distance round the stem, leaving only those roots attached which were large and bare, and without any supply of small fibres, those having been separated in the act of removing the earth; and, with as much soil attached to the part where the roots issue from the stem as the nature of the means of conveyance would admit of, the trees were again put into the earth; but in nine instances out of ten the trees so dealt with never again recover so far as to assume a tolerably healthy or respectable appearance.

2227. This has indeed been the most primitive system of transplanting large trees; and as an improvement upon it, a system of previously preparing the roots for removal has been adopted, which, indeed, considering all the circumstances, has been a decided improvement upon the old style, but has not yet been attended with that amount of success which the nature of the case demands, and which it seems quite possible to attain. The system of preparing trees for transplanting, as practised for a number of years past, is this: Any large tree, the transplantation of which was anticipated, had a trench dug round it, at such a distance from the stem of the tree as was considered expedient for the purpose of removal, according to the size of the subject to be handled. This trench was dug so deep into the earth as to cut all the side roots as far down as those were found. It was then again filled up; but if the soil was naturally bad, a quantity of better was substituted, with the view of the more readily encouraging the cut roots attached to the tree to push out fresh ones to act as feeders when the tree was removed to its new site. In this state it was again left for a period, generally of two years, when all the cut parts of the roots had pushed out afresh into the new soil. The tree was now considered fit for removal, which was performed in the following manner:—

2228. In taking away the earth from its roots, the workmen began first by opening a new trench all round, and exactly upon the outside of the one which had been formerly made, making the level of its bottom a few inches under that of the latter, with the view of the more readily getting under the level of the supply of young roots, now supposed to be made within the compass of the first trench. This being done, the workmen, with small picks made for the purpose, loosened very carefully the body of the soil, as contained in the previously made trench, beginning upon the outside of the circle, and gradually working in among the young roots made, so as to separate them from the soil; and as these progressed, others were employed in throwing out the soil thus loosened, taking care to disturb or injure any of the small tender roots, now hanging loose, as little as possible. In this manner the men followed each other regularly, till they had the ball of earth contained within the compass of the first trench well reduced, and all the young fibrous and other roots, as these appeared, preserved as well as the nature of the work would admit of. When all these had been separated from the soil on the outer part of the ball, the remaining part, immediately round the bottom of the stem, was preserved entire, and taken along with the tree; and as soon as this part had been undermined, or freed of any hold it had perpendicularly in the earth, a pole, which was fixed upon an axle with a pair of wheels, was applied to the stem of the tree, and tied firmly to it, by which means it was pulled down, with the ball and all its appendant roots resting upon the axle and hanging between the wheels. In this state the tree was drawn by horses to the place where it was to be replanted. In the act of replanting, the bottom of the pit, which had been previously made for the reception of the roots, had a quantity of good soil put over it: the tree was then put in, and the roots spread out, and replanted in as careful a manner as possible, new soil being used when that was considered necessary for the health of the plant. In all cases where the situation was an exposed one, and the ball of earth light in proportion to the top-weight of the tree, large sticks or ropes had to be used, in order to keep the newly-planted tree firm in its position, until the roots had become properly established in the new soil.

2229. Having thus given a very brief outline of the manner in which the transplanting of large forest-trees has been conducted by many hitherto, it now remains for us to examine a little as to how far that system of operation fulfils the conditions required, and how far it is commendable or not. First, then, we are aware that no tree can form a healthy development of leaves and branches unless it be supplied with a corresponding healthy development of roots, by which to draw food in the form of solution from the surrounding soil; and yet no healthy tree, although deprived of a portion of its roots, will sustain any permanent injury, provided it be allowed to remain undisturbed in the soil till it has again replaced those roots, if, after new roots have been made, they be preserved from further injury. Secondly, that the merely hard-woody portions of the roots of a tree are not of themselves capable of drawing nourishment to any considerable extent from the earth, unless they be well furnished with the small terminal rootlets, which are of a soft, spongy texture, and are considered as the mouths by which the sap is sucked from the earth into the plant; and, thirdly, that those very rootlets, which are so essential to the preserving in a healthy state any tree or plant, are very susceptible of injury, either by being unduly exposed to the action of the atmosphere, or by their fine outer coats or skin coming roughly in contact with any body harder than themselves. Applying those facts, as they are known to affect vegetable life, to the operation of transplanting large trees, as already described, we must conclude thus: The plan of digging a trench round the trees to be transplanted, if not overdone, has no permanent bad effects upon the constitution of a tree; it gives, no doubt, a temporary check to the system of the ascent of the sap, but as soon as the roots have again renewed themselves, the strength of the sap will gradually resume its former tone; therefore, as regards this part of the operation, no important evil can arise; and the first head, as laid down, is thus dismissed. But in applying the second and third heads, the system of transplanting formerly stated is much at fault; for, in removing the soil from the very soft and tender rootlets, which were so recently produced by nature for the support of the tree, their functions are so much damaged and impaired, in consequence of coming in contact not only with the strong atmosphere, but with the hands and implements of the workmen, that they are almost all rendered unfit for any further healthy action. It is in this respect alone that the operation is *not* adjusted to the natural wants and requirements of the subject handled, but is diametrically opposed to sound natural principles. On examining trees transplanted on this system, they may sometimes indeed have a fair outside appearance, like the hectic flush of a delicate person; but, on close examination by an experienced eye, the reality is at once evident: external indications are at once discerned that the inward constitution of the subject is gone, and, consequently, that its duration will be comparatively short. Besides this, the machine which has been in general use for the purpose of removing large trees by the method above detailed is so very imperfect, that no tree of any considerable dimensions can, with any degree of safety, be conveyed by it. We shall describe our method of preparing large trees for transplanting in the following section.

SECTION II.—METHOD OF PREPARING LARGE TREES FOR TRANSPLANTING.

2230. In the transplanting of large trees, much of their after success depends upon the character of the subject selected; therefore, in selecting large trees for transplanting, we lay down the following seven heads to be kept in view. First, a tree of any given species is better supplied with small fibrous roots when growing upon a light porous soil than on a soil of an opposite character. Second, the roots of trees growing in a heavy or clay soil extend themselves to a greater distance from the main stem in search of food than they do when growing in a light and open soil. Third, the small fibrous roots of trees are most plentifully formed near the surface of the ground; and the deeper in the earth the large roots are found, the fewer fibrous roots are upon them. Fourth, the more confined any tree is among others in a wood, the fewer and the weaker are its roots; and the more exposed it is to the free influence of the surrounding air, the more abundant and healthy these are. Fifth, the more that a tree becomes clothed with branches, the better is it supplied with small fibrous roots. Sixth, in soils of a naturally cold and damp character, the roots of trees are few, weakly, and unhealthy; and in those of a naturally dry character, the opposite is the case. Seventh, the principal masses of the fibrous roots of trees are generally found to coincide with the extension of their branches; and they are also generally found most numerous upon that side of a tree which has been most freely exposed to the influence of light and heat.

2231. Having given the seven foregoing heads as sign-posts for guidance in selecting large trees of a proper character for transplanting, we shall now refer to them in their order,—describing our method of preparing large trees for transplanting as we proceed. The first head laid down is,—a tree of any given species is better supplied with small fibrous roots when growing upon a light porous soil than on a soil of an opposite character. Being, then, aware of this fact, we advise that, in selecting large trees for transplanting, the subjects should, if at all possible, be taken from land of a light and porous character, as in such soils trees are invariably better supplied with fibrous roots than they are on soils of a stiff and clayey nature. In selecting a large tree for transplanting, say one of 30 feet in height, in all cases choose it of a fine spreading habit, with branches fully corresponding to its size and height. Having, then, selected a tree growing on soil of a light nature, and of the habit described above, the next step is to have it dealt with in the following manner, preparative to its being transplanted in due time after. First, take a cord and tie it loosely about the bottom of the trunk of the tree; and then, with the cord in the hand, held at 3½ feet from the stem as a centre, describe a circle all round, making the diameter of the ball of earth fully 7 feet. This being done, have a trench dug all round on the outside of the inscribed circle about 24 inches wide, and so deep as completely to go under all the side roots. As the digging of the trench progresses, have all the roots carefully and smoothly cut, as those appear upon the inner side of the trench, so as to leave no roughness on the wounded parts for the lodgment of water about them. Under the depth of 2 feet from the surface it will be found that the roots are scarce, and with few or no fibres; therefore, at this stage of the operations, have these more closely cut in, so as to cause them to produce a more plentiful supply of small roots for the future health and establishment of the tree when removed. Accordingly, have the ball of earth, situated between the trench and the stem of the tree, undermined all round, leaving it only about 20 inches deep upon the outside, and gradually sloping it downwards as you approach the centre of the ball under the tree, where it may be fully 30 inches deep. This undermining, however, should not be carried to such an extent as to come in contact with any of the tap-roots situated immediately under the stem of the tree. Were this done, it would give too severe a check to the tree, as we consider that the tap-roots are essentially necessary for its support—at least, until the roots, which are now supposed to be shortened, shall have pushed out fresh young ones for drawing in a supply of nourishment. Merely undermine the ball of the earth formed about the roots, to the extent of about 2 feet inwards from the perpendicular of the same all round. Having this part of the work, as detailed, all finished, next, with a small pick, take away all loose pieces of soil from the sides of the ball all round. In doing this, wherever a deficiency of roots is found, apply the pick, and have the soil taken away till you come in contact with roots; and wherever these are found, at once leave off without disturbing them further. At this stage of the operations, the ball about the roots of the tree will present rather a rough appearance. On some parts the cut points of pretty large roots will protrude, and on others the earth will be hollowed out, showing that many fibrous roots are lying there; but the meaning for this will be better understood after we have explained how we finish the work.

2232. Before commencing with the work of preparing the ball of earth around the tree as above detailed, have ready a quantity of half-rotten vegetable mould, and to this add an equal quantity of light peat mould, mixing the two well together; and of this compost put in about 9 inches thick all round the ball. In doing this, begin at the bottom or the lowest point of the excavated ground, replacing the soil which was thrown out gradually with the compost; putting it in next the roots of the tree to the thickness already stated, and giving it a slight tramp with the foot in order to compress it a little. The soil which had been removed is then returned behind the compost, and to this also a firm tramping should be given, making it pretty solid, and keeping all the worst of the soil thrown out next the compost. In putting in the compost about the roots, wherever there is a hollow part, as made where there had been few roots upon the ball, have them completely filled up with it, extending it, at the same time, to the ordinary thickness round the outside area of the ball; thus, in places where any of those hollow parts occur, the compost will be sometimes fully 2 feet in thickness—this being with the intention of encouraging an extra supply of roots to grow at such parts. In this manner go on with the work till the whole extent of the ball is equally done; and when the surface level of the ground is reached, spread about 6 inches of the compost over on the ball—in which state the preparation of the roots of the tree may be considered completed. In preparing large trees for transplanting, we think it well to have the principal large branches shortened in to the extent of about one-third of their length. In doing this, however, do not attempt anything like a regular pruning of the tree by taking off any branches from the stem; but merely shorten any large overgrown limbs which appear to have an undue ascendancy upon the tree, and to require an undue proportion of the sap of the tree to support them.

2233. Having thus detailed our mode of preparing trees growing upon a light soil for future transplantation, we shall next give a similar statement relative to others growing upon a heavy clay soil, exemplifying the practical bearing of the second head formerly mentioned—namely, the roots of trees growing in a heavy or clay soil extend themselves to a greater distance from the main stem in search of food than they do when growing in a light and open soil. In preparing a tree for transplantation, which is growing on a heavy description of soil, have a trench opened around its roots in the same manner and to the same extent as described in the immediately foregoing paragraph. When the trench is all thrown out, and the ball of earth surrounding the tree undermined as in the former case, take the pick, and commence taking off a rather large quantity of the stiff clay soil forming the ball, and especially in places where there appear to be no roots existing. In this case it will in all probability be found necessary to reduce the ball very much—in several parts right through to the bottom of the trench; but wherever roots of any size appear, however small, at once leave off there, and in this way reduce the ball all round till roots of some size or other appear. This part of the operation being concluded, next have a quantity of vegetable mould, as before described, and an equal quantity or bulk of well-rotted turf mould, well mixed together, and have all the openings in the ball properly filled up with it, making it rather compact in among the roots by pressing with the hands. When the openings which were made with the pick are all completely filled up on the flat of the ball, commence next and put the compost all round on the outside, keeping it about 12 inches in thickness between the clay soil put in behind, and the nearest of any one of the points of the roots projecting from the ball. This should be done in exactly the same manner as in the former case—always observing to pack the clay very solidly behind the compost put in, and the compost itself more slightly; and when the whole is levelled to the surface, cover the top of the ball with the compost to the thickness of about 9 inches. We may also mention that, after the tree is finished, an open drain should be made from the level of the bottom of the trench; for, from the stiff nature of the soil, it may be anticipated that water will lodge in the trench and destroy the health of the young roots which are expected to be made. This we strongly recommend as being absolutely necessary in such work, wherever the soil is heavy; as, by the simple process of making an open drain from the bottom of the trench, no water can remain there, and the tree must altogether be preserved in better health, as well as have the advantage of a more healthy state of soil in which to form new roots.

2234. With regard to the third head stated—namely, the small fibrous roots of trees are most plentifully formed near the surface of the ground; and the deeper in the earth the large roots are found, the fewer fibrous roots are upon them—this is a fact which every one will find verified in his operations in preparing the roots of large trees for transplanting; indeed in most cases it will be found that there are comparatively few fibrous roots found under 20 inches from the surface; and to encourage the growth of these under that depth is our object in undermining the ball of earth, and putting a quantity of soil favourable for the production of roots under that part.

2235. We now come to the fourth head—namely, the more confined any tree is among others in a wood, the fewer and the weaker are its roots; and the more exposed it is to the free influence of the surrounding air, the more abundant and healthy these are. Under this head we may remark that trees of any kind which have been injudiciously drawn up in a plantation, are the most unfit subjects that can be chosen for transplanting; therefore, in choosing trees for the purpose of transplanting, they should always be taken from the outside of a wood, where they will have had plenty of pure air to develop their branches, and, which is the natural accompaniment of this, a large supply of fibrous roots. By the way, we ought to observe that any tree which is to be transplanted, of any size, should be possessed of a good, sound, thick, and fleshy bark. If a tree has bark in that condition, it is never easily affected by sudden change of exposure, whereas one with thin bark is easily hurt. We may also further remark on this point that, in choosing large trees as subjects for transplanting from any part of a plantation where the trees may have been formerly much confined, it should be carefully seen that the bark of the tree to be removed is in a good healthy state.

2236. We now come to say a little relative to the fifth head mentioned—namely, the more that a tree becomes clothed with branches, the better is it supplied with small fibrous roots. In the choosing of large trees for the purpose of transplanting, this is a point which should never be lost sight of; therefore the planter, in looking out for specimens which he would have with good roots, has only to observe the natural state of the tops: if they are spreading and branchy, he may rely upon plenty of good roots; and if they are tall, with few top branches, he may depend upon few roots existing upon them; consequently, such would make the very worst trees to transplant with any hope of success.

2237. We may merely observe, relative to the sixth head—which is, in soils of a naturally cold and damp character, the roots of trees are few, weakly, and unhealthy; and in those of a naturally dry character, the opposite is the case—that in all cold wet soils, the growth of trees is invariably slow as compared with others upon a dry soil; this arising from the weak and unhealthy state of the roots in the one case, and their more vigorous state in the other. He, therefore, who would wish to remove trees from a naturally cold and wet soil, must first, if he desires to be successful in the operation, have the ground well drained about the specimens to be removed; and either at the time of draining, or after the trees show more vigorous signs of health from its effects, the trees may be prepared in the roots, and afterwards removed with safety.

2238. We now come to say something relative to the seventh head—namely, the principal masses of the fibrous roots of trees are generally found to coincide with the extension of their branches; and they are also generally found most numerous upon that side of a tree which has been most freely exposed to the influence of light and heat.

In reading the above conclusion as laid down, it must not be understood to signify that masses of fibrous roots growing from any tree never extend beyond the spread of its branches. On the contrary, the principal masses of the fibrous roots of a tree may sometimes be found to extend very much beyond this; but in such a case there must exist an extraordinary cause—that is, in all cases where a tree is found growing in a soil of equal fertility throughout, the principal masses of fibrous roots will be found generally to coincide with the extension of its branches; while, on the other hand, if any extraordinary nourishing property exist not far distant from the roots of a tree, such as a watercourse, a stratum of soil of a superior nature to that in which the tree may be standing, or heaps of manure, &c., they will far outgrow their usual pace in order to reach such extraordinary nourishment; and when they have, as it were, attained their desired possession, the principal masses of fibres will grow out and congregate there, although at a considerable distance beyond the extension of the branches. This may often be observed in the case of trees growing on the side of a wood where a well-cultivated piece of land may happen to be: then the roots will be found in tufted profusion in the land, and at a great distance from the trees themselves; and the same thing may be observed in the case of the roots getting into drains. All these cases, however, are extraordinary, and are not to be taken into account in speaking of the nature of trees as found under ordinary natural circumstances.

Admitting, then, as a truth founded on practical observation, that under existing circumstances the principal masses of fibrous roots of trees are generally found to coincide with the extension of their branches, an important question naturally arises, Should we not, in the removal of a large tree, carry along with it a ball of earth equal to the ordinary spread of its roots in the earth? or, if not to the extent of the spread of the roots in the earth or the branches in the air, by what rule are we to be guided in the operation?

Relative to this, as well as to many other matters of forest operations, different opinions are held. Some maintain that, in the act of transplanting a large tree, all its roots should be bared and traced out to their full extent *as nearly as possible*, and removed entire along with the tree, without any respect being paid to a ball of earth; while others hold that no previous preparation is necessary for the removal of any tree, but that lifting a ball of earth, varying from 8 to 12 feet in diameter, according to the size of the tree, is quite sufficient for its safety, without any attention to the natural spread of the roots in the earth. Such opinions are so contradictory in themselves, and so void of sound natural principles, that we shall at once dismiss them as unworthy of attention. We live in an age in which mere assertion has little weight; therefore, in answering the question as above laid down, we must attend to the effects of experience, as that is based upon sound natural principles relative to the laws of vegetable life.

2239. We have already said, in the section immediately preceding this, that no tree can form a healthy development of leaves and branches unless it be supplied with a corresponding healthy development of roots by which to draw food, in the form of solution, from the surrounding soil; and yet no healthy tree, although deprived of a portion of its roots, will sustain any permanent injury, provided it is allowed to remain undisturbed in the soil till it has replaced those roots.

Now, admitting the above assertion to be true, as we have found it to be in our own experience, the reader will at once see that, to deprive a tree of its roots, and to remove it to another soil at the same time, is the very means to prevent its making healthy progress in future; and, at the same time, he will readily see that although any tree should lose a portion of its roots, if it be allowed time to replace them without being further disturbed till it has done so, no permanent injury will follow. Keeping in view, then, that a tree cannot make a healthy development of leaves and branches unless it be supplied with a corresponding healthy development of roots, and that it will not sustain any permanent injury though it lose a portion of its roots, if it be allowed to remain undisturbed till it replace them, we have laid down as a rule for our own guidance in the transplanting of large trees, to have their roots previously prepared by cutting them in by means of a trench dug all round, at a distance from the tree equal to *two-thirds of the diameter of the spread of the branches*—that is to say, if the diameter of the spread of the branches be 12 feet (not including the extreme points of large branches), the diameter of the ball of earth inside the trench should be 8 feet, and so on in proportion.

2240. To the inquiring reader another question will naturally arise here—namely, What object is gained by the cutting of the roots by means of a trench; and why define two-thirds of the diameter of the spread of the branches in preference to any other distance? Our answer, which is entirely based upon the result of our own experience, is this: With regard to the object gained by the cutting in of the roots previous to the removal, let any one who may have two rows of oaks or any other kind of hardwood trees in the nursery of a pretty large size, say 5 or 6 feet high, have all the side roots of the one row cut in with the spade upon each side, say about 6 inches from the trees in the line, but not so deep as to cut any of the *tap-roots*, which are meant to supply the tree with food till new ones are made upon the sides, and leave the other row uncut in their usual natural state. In twelve months after the trees in the one row have been cut in, have them lifted, and the side roots will be found very plentiful in small fibres, and in an excellent state for being safely removed to the forest-ground; whereas, on lifting the row of the same age, the trees of which were left uncut, the side roots will be found extremely spare, and the fibres for the most part left in the ground; and on planting the trees as contained in the two rows out into the forest, under equal circumstances of soil, situation, and management, the observing forester will very soon have occasion to decide, without the least hesitation, that those which had their side roots cut in twelve months previous to their being removed, are far more healthy, and making more rapid progress than those which were not cut till the time of their removal. It is exactly on this same natural principle that we advise to have the side roots of all large trees cut in previous to their being lifted; and we may further state, regarding this point, that we have so often practised this method of cutting in the side roots of pretty large trees in nursery-rows previous to having them transplanted to the forest-ground, and have found the effects of the operation so beneficial, that our mind is now quite decided as to the improvement that takes place in trees so managed, compared with others which may be lifted and planted out in the usual manner. The object, therefore, gained by cutting in the side roots of a tree previous to having it transplanted is—a great supply of young fibres, all in readiness to draw in nourishment as soon as it is put into its new site, which is never the case when a tree is removed without any previous preparation.

2241. Our reason for defining two-thirds of the diameter of the natural spread of the branches in preference to any other distance is, that at that distance from the stem of a tree all the large and hard or matured portion of the root is enclosed within the circumference of the ball, while on the circumference of the ball itself, at that distance from the stem, the roots are found pretty regularly ramified, and of a character and consistency of wood the most likely to send out numerous healthy fibres for the future support of the tree.

2242. Having now said so much regarding removing large trees, we shall conclude the present section by laying down a kind of abstract of the manner of proceeding with the preparing of large trees for transplanting, which, let it be understood, is the system we have laid down for our own guidance, and is entirely based upon the results of our own experience.

2243. *First,* In choosing a tree of a large size for removing to another place, we first see if it be well clothed with branches,—for if the branches be few, the roots will be correspondingly few.

Second, If one or more of the branches forming the top appear to bear an undue proportion to the main stem, we have such shortened in by at least one-third of their whole length, but never in such a way, or to such an extent, as to give the tree a formal or artificial outline. This we do with the view of reducing, as far as consistent with good management, the demand for food upon the roots after they have been cut in.

Third, Taking the perpendicular drip of the general mass of the points of the branches, as the circumference of a circle round the stem of the tree, after the strong limbs have been shortened in, we next take two-thirds of that as the diameter of the ball of earth to be left inside the trench to be formed.

Fourth, The circle being inscribed round the stem of the tree, we next take out a trench, on the outside of that circle, from 18 to 36 inches broad, according to the size of the tree, keeping the earth to the outside, and have all roots as they appear upon the inside of the trench smoothly and carefully cut, and that to such a depth as the roots of the tree may be found, which is generally from 2 to 3 feet under the surface.

Fifth, The trench being made, we next pare off with the spade all loose soil from the surface of the ball of earth now formed on the roots of the tree; and, at the same time, with a pick take away all earthy parts of the ball in which no roots exist, with the intention of putting in soil of a nature congenial to the growth of roots; and in order to encourage the more readily that growth on the under part of the ball, we have it undermined to the extent of 2 to 3 feet within the perpendicular, and the earth thrown out to be replaced by better soil.

Sixth, All the parts of the work as above stated being finished, we next bring forward—which is understood to have been previously prepared—a quantity of any light vegetable mould, such as has been already described, and have it put about the roots of the tree to the extent and in the manner already detailed.

Seventh, If the trees be originally growing on a soil of a light nature, which is naturally congenial to the production of numerous roots, they may be safely removed in two years after the roots have been cut in; but if upon a soil of a heavy or clayey nature, which is not so congenial to the growth of these small roots, the trees so situated will be the better of remaining three years in their preparative state; for as the original quantity of roots was comparatively small, the more time will be required to make good that deficiency in the good soil put in for that purpose.

2244. Some will probably consider the system of preparing large trees for transplanting, as herein laid down, an expensive operation; but those who may, at the first glance, and without due consideration, think so, may be assured that it is the cheapest and most satisfactory plan in the end. There is no doubt that trees may be removed at a cheap rate from one place to another without any such preparation as has been advised; but the grand question is, Can they be otherwise more cheaply removed with an equal hope of success as to the object in view? We are not aware that they can; and this has been shown from the case of others, as well as from the results of our own experience; for it is most reasonable to suppose, even by those who may have had no practical experience of their own, that a tree removed from its original site, having numerous small fibres formed at all the extremities of its roots, must have a much greater assurance of future health than one removed without any of these. No proprietor of judgment and taste would hesitate one moment as to the outlay of a few extra pounds upon such a work as the transplanting of large trees, when he is aware that by the system of preparing their roots he is likely to have the greatest amount of ultimate satisfaction.

The next thing to be considered is the work of removing large trees after they have been thus prepared; and this will constitute the subject of the following section.

SECTION III.—METHOD OF TRANSPLANTING LARGE TREES, AND DESCRIPTION OF MACHINES FOR PERFORMING THAT OPERATION.

2245. In order to secure perfect success in the removal of large trees, it is necessary that a machine of great power should be constructed, by means of which a whole tree, of whatever dimensions, with its ball of earth and roots, should be lifted and conveyed in an upright and natural position, and laid down in its new bed as entire as when taken up. Now, keeping this in view, and having already pointed out the kind of preparation that appears to us necessary for the safe removal of all large trees—we next come to point out how trees thus prepared may be safely removed by means of powerful machines.

2246. There are many different kinds of machines in use at the present time for the removal of large trees, but as we have not found any more suitable for the purpose than those we are about to refer to, we recommend them in preference to any others.

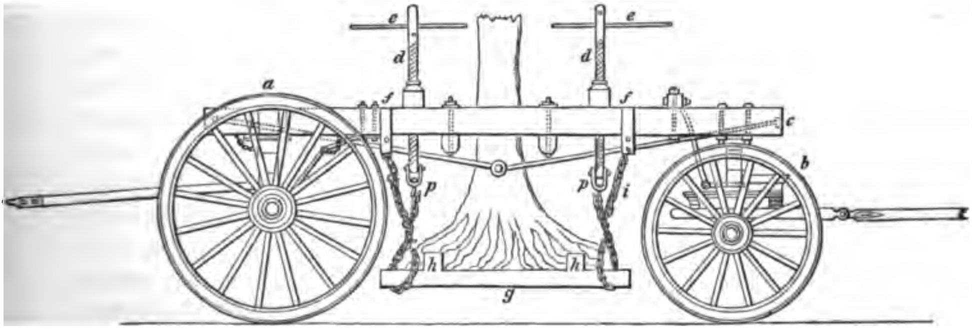
2247. The first machine to which we shall refer is the one that was so extensively used at Kingston Hall, near Derby, some years ago, for large tree lifting. There, by means of the machine we are about to describe, a bare knoll was transformed into a well-wooded park within the short space of some four or five years. This machine is represented in the accompanying engravings.

2248. Two machines of the kind here represented were used in the transplanting of the large trees at Kingston Hall, both of the same construction, but different in power—the one used for transplanting trees of 25 feet in height and under, and which may be capable of safely removing a weight of about 5 tons; the other was for transplanting trees from 30 to 40 feet in height, which is capable of safely removing a weight of from 10 to 15 tons—that is, including the tree and its ball of earth attached. Trees of the latter weight were removed by the more powerful of the two machines used, which proves that it is in all respects well adapted to the purpose of removing large trees with their balls entire.

2249. Before entering into detail as to the manner of working the machine, we shall first give a statement as to the nature of its construction.

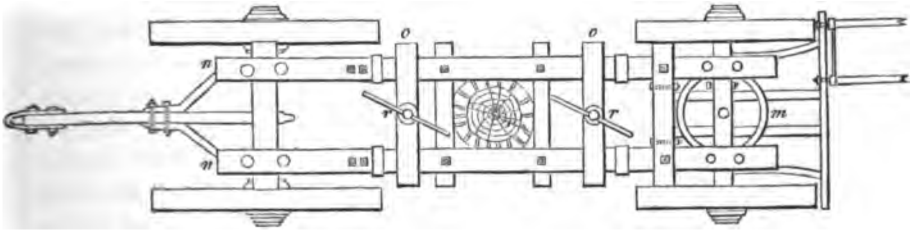
It consists of two pairs of wheels, each pair working upon a strong axle of superior quality. In the largest machine, as referred to above, each pair of wheels is about 9 inches broad in the rings. The pair situated on the front part (see engraving at *b*) are about 5½ feet in diameter, and the pair situated on the hinder part (see engraving at *a*)

Fig. 165.



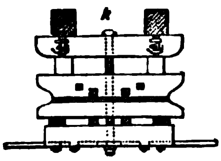
SIDE ELEVATION.

Fig. 166.



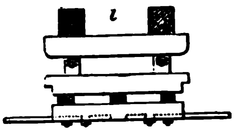
GROUND-PLAN.

Fig. 167.



END SECTION.

Fig. 168.



END SECTION.

are about 7 feet in diameter, and distant from each other about 15 feet—thus making the length of the machine, from the one axle to the other, 15 feet. On each of the axles is placed a strong frame, in order to raise the horizontal bearers to a convenient height, and at the same time with the view of making the whole machine move in a workable manner. (See section of front frame *k*, and section of back frame *l*.) The front frame, we may also state, is made to turn upon a horizontal wheel, in the same manner as in the case of a carriage, for the easy turning about of the machine in any required direction, as is represented in the ground-plan of the tree-lifter at *m*. Resting upon the frames, as is shown in the front and back sections, and parallel to each other at a distance of about 2 feet apart, are two strong beams of wood, about 10 inches deep by 6 broad. (See side elevation of the tree-lifter at *c*, and also on the ground-plan at *n n*.) Those beams are fastened to the frames placed above the fore and aft axles, by means of strong iron bolts, which can be unscrewed as occasion may require; and placed across upon those horizontal beams again are two others (see ground-plan at *o o*), into which the jack-screws are placed. The screws are also shown in their working state in side elevation *d d*, with their cross-handles for turning, *e e*. On the under part of those jack-screws, as passed through the cross-beams, are attached the strong chains by means of which the tree is principally taken out of its place (see *p p*); and, as an assistant to them, there are side chains attached to strong iron rings fixed upon the beams (see *f f*). Those side chains are made to act along with the others attached to the screws, and are also found necessary to retain the weight of the tree and its ball of earth during the reversing of the screws for a new hold. The horizontal planks upon which the ball of earth rests, supported by the chains, are shown on side elevation at *g*; and the two cross planks, which are placed upon the horizontal ones for the better support of the ball, are also shown at *h h*. Those planks require to be made of the best oak wood, not less than 4 inches thick.

2250. Having now given a brief description of the construction of the machine, it remains to be stated how the operation of transplanting a large tree is accomplished by it.

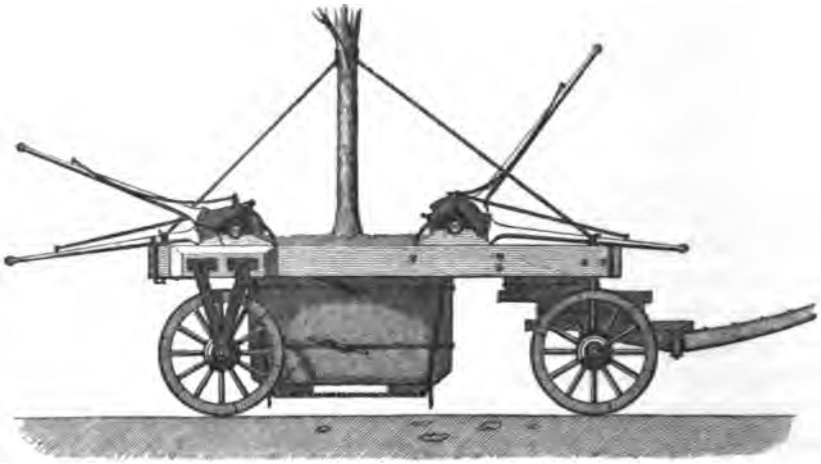
"The work of transplanting a tree with the machine above referred to is perfectly simple and easily understood. Some of the trees that were transplanted on the park at Kingston Hall were brought from considerable distances by means of this machine, and many of them were 40 feet in height, and weighed each, including the ball of earth and the machine, upwards of 10 tons, and these were drawn by 9 horses. We shall now, therefore, give the following details as to how this was accomplished. The trees to which we now allude were growing on the outskirt of a wood. The ground around the tree was cleared, and at 4½ feet from the stem of the tree a circular cutting was made to the depth of about 3½ or 4 feet, and about 2½ feet in width. This done, then on the most open side of the tree a sloped cutting was made, from the surface of the ground to the bottom of what may now be called the ball of earth, and a similar sloped opening was made on the opposite side of the tree. The first of these sloped cuttings was made for the purpose of drawing out the tree up this slight incline to the surface of the surrounding ground. The circular opening in the earth around the tree, and the two sloping roads on each side, being now prepared, the workmen commenced to undermine the ball of earth: this being done all around, four stout oak planks, long enough, were placed under this ball of earth in front and behind—that is, crossways to the direction of the machine; and under these two others were placed lengthways, with their ends in the direction to back and front of the machine. It will now be understood that these four oak planks under the ball of earth cross each other at their four extremities; and around their extremities, at each of the four corners, four sets of strong iron chains are fastened. A reference to the diagrams given will assist in explaining this. The first set of chains brought into play were those attached to the bottom of the jack-screws. Being made as tight as possible over the ball of earth, they were then hooked on the end of the jack. The two jacks were then turned by two or four men each, as the case may require, until the tree and the ball of earth were raised from the ground about 6 or 10 inches. The jacks were then permitted to rest, and what is called the side chains were then put in requisition. These, as we have already stated, are fastened to the planks under the ball of earth at the same point as the others, the opposite ends being made fast to the side beams, as shown in the engraving. This being done at the four corners, the jacks are then reversed, and the first set of chains slackened; the weight of the earth and tree is then sustained by the side chains. The first set of chains were again adjusted, and made as tight over the ball of earth as manual power can effect. The jack is again run down, and again attached to the chain at the lowest point it will reach. The jacks are once more applied, and run up till the end of the screw has been completely worked up to the under side of the cross beam on which it rests. By this second lift the jacks have probably gained upon the 6 or 10 inches which they made at the first lifting, and the bottom of the ball is now 15 or 20 inches from the ground. The side chains, which are now quite slackened by the second lift of the jacks, are again made as tight as possible: this accomplished, and all securely and equally fastened to the side beams again, the jacks are gently reversed, till the weight is equally divided betwixt the side chains and the jack chains. The tree is now in a condition to be drawn out, unless it should be necessary to give it a third lift with the jacks, so as to raise it still higher from the ground; and if so, the side chains must always be attended to, as already described. They may be properly called the guard-chains, as they prevent accidents in the event of breakage of any of the jack-chains, when the former would take the weight of the tree, and prevent its falling. About 10 or 15 feet up the stem of the tree, four ropes extend from this point to the two front and two back corners of the machine; and this is all that experience has found necessary to preserve the tree in its perpendicular position during its transport on the machine to its future place of growth. The perpendicular position of the tree is, however, very greatly secured by the four side or guard chains. We have now to describe the mode of introducing the stem of the tree within the machine. This is effected in the following manner: The machine is drawn as near to the tree as circumstances will allow; it is then taken to pieces by unscrewing the different bolts —that is, the main horizontal beams are unfastened, and thrown over the wheels on either side. The larger hind-wheels are then placed in their proper position on the sloped cutting behind the tree, and the smaller fore-wheels on the sloped cutting before the tree; the large beams are then lifted on to their places, one on either side of the tree, and made secure with the iron bolts and the requisite fastenings. The tree then stands with its stem betwixt the side beams, and with a pair of wheels behind and another before. The chains and jacks are then applied as already described, and thus the process is complete. The next and only point deserving further allusion, is that of planting or placing the tree where it is ultimately to grow; and this is effected in the following way: The hole, sufficiently large to receive the ball of earth, is dug the necessary depth; then, on the opposite sides of the hole, a sloped cutting, wide enough to admit the machine to be drawn down and through it, is also provided. Into this cutting, therefore, the machine and tree are drawn, and through which the team of horses first pass. When the tree has reached the proper point, the machine is permitted to rest; props of brick or stones are then raised at the four corners immediately under the ends of the cross planks. These props may be three or five bricks in height; and when all is prepared in this way, the jacks are reversed, and the ball of earth gradually lowered down, till the ends of the cross planks rest upon the corner props, and the tree has taken its proper perpendicular position; and this is effected by the raising or lowering of these corner props. All being adjusted, any opening that may remain, betwixt the bottom of the ball of earth and the bottom of the hole provided for the tree, is filled up with earth—the whole being made firm around and under the roots of the tree. The brick or stone props are then struck out, and the planks removed—a process easily effected, as the tree now rests upon the earth which has been placed under and about it. These planks are, however, well ironed at each end, that, in case of any difficulty in their removal, a horse or horses may be readily yoked, and the planks withdrawn."

2251. Having now, we think, fully explained the nature and working capabilities of the machine, which we recommend for the safe transplanting of large trees, we may further state that it is evident that, by increasing the strength and power of the machine, it may be made to remove a tree of any given weight and dimensions. The machine just referred to is superior to any other thing of the kind that has ever been introduced to the notice of landed proprietors for the speedy ornamenting of their home grounds; and where proprietors will take the trouble to prepare their trees in the roots, in the manner which we have recommended in the section immediately preceding this, and allow them to remain for two or three years, till the ball of earth has become one mass of fibrous roots, the whole may be then lifted, by means of this machine, in one entire piece, without disturbing almost a fibre; and any tree removed in such a favourable state will never show any symptoms of want of vigorous growth, which has not been the case with most large trees hitherto planted on principles which left the young roots exposed and injured in the act of removal.

2252. The French use a different kind of machine for transplanting their large trees on their public parks. We shall here give a description of the one chiefly used by them, which, although perhaps not of so powerful a construction as the one just referred to, is notwithstanding well adapted for lifting trees of an ordinary size. The description which we shall here give of this machine, with its engravings, is taken from 'The Parks, Promenades, and Gardens of Paris,' by Robinson. The machine is represented in the accompanying figure.

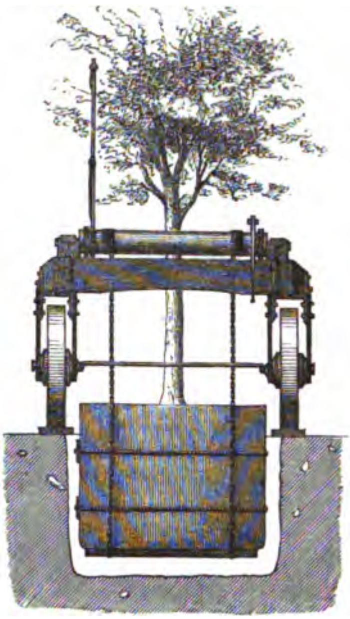
2253. The way in which the removal of large trees is managed with the machine, as represented in fig. 169, is this:—"We take, for example, a specimen tree, 30 years old, 30 feet high, the trunk of which has a circumference of 3 feet at a height of 3 feet from the ground; its total weight, with the earth-ball, being nearly 2 tons. The operation is commenced by staking out, round the stem, the circumference of the earth-ball, which will be, on an average, about 4 feet in diameter for most species, and larger according to the size of the trees to be removed. A second concentric circle is then made about 2 feet outside the first, the space between which will be the place for the trench to be dug for preparing the tree. The soil is then removed from this trench to the depth of 3 feet, and the small and delicate roots are drawn out of the earth, left hanging, and carefully preserved. The earth-ball is then undermined, to prevent the roots from adhering to the subsoil; two thick planks, a foot wide, and a little longer than the ball, are placed underneath parallel with the width of the cart, so that they sustain the weight of the earth when the tree is lifted. Privet stems are now placed vertically, close together, all round the earth-ball, tied at the top and bottom with ropes, so as to prevent the earth from crumbling away, and also to protect the small roots from the inclemencies of the weather. The removal of the tree is then commenced in the following manner:—Two stout thick planks, strong enough to support the cart with the tree slung in it, and a little longer than the entire excavation, and having iron plates about 2 inches higher than the surface, bolted on each side so as to prevent the wheels from slipping off, are placed, parallel to each other, across the excavation, with the exact width existing between the wheels. The movable bars at the back of the cart are then removed, and the cart is backed into the ways until the trunk of the tree is exactly in the centre of the frame. The movable bars are then put in their place again, so as to strengthen the back of the wheels, which do not run on an axletree, but are fitted in wrought-iron frames hanging from the upper part of the cart, as shown in figures 169 and 170. The chains attached to the rollers on each side of the cart (as shown in fig. 170) are now lowered, and passed under the planks before described, which are placed under the earth-ball. When all is fast, four workmen begin simultaneously to turn

Fig. 169.



the handles attached to the cast-iron cogwheels, by which great power is obtained on the rollers. The tree is raised slowly and steadily until it just swings clear of the ground, and then nothing is left to be done but to steady the tree before it is hoisted up to its proper height. For this purpose there is at each corner of the cart a strong WROUGHT-IRON hook, to which is attached a block, through which runs a strong rope fixed at the other end to a leather collar. These four ropes are then raised up together, and the collar firmly fastened on the stem of the tree about 7 or 8 feet from the top of the earth-ball. The tree can now be easily removed without fear of its falling over.

Fig. 170.



" The horses are then attached to the cart, which is drawn slowly off the ways, and the tree can be removed with safety to its future resting-place. If the tree be vigorous and healthy, a hole a little wider than the one from which it has been removed should be dug beforehand: the earth, being placed carefully on one side of it, should be of a kind to suit the tree about to be planted; and if not, it should be replaced by suitable soil." The hole in readiness, and suitable soil prepared for the tree, " the planks or ways are placed in position, as before described, and the cart is very carefully drawn on them until the earth-ball is exactly in the centre of the hole. The tree is then slowly lowered, and when it touches the ground, the guy-ropes from the corners of the cart are pulled tight, so as to have the tree perfectly upright and steady; the chains are unfastened and hoisted up round rollers; the two planks beneath the earth-ball are undermined and removed, and the privet shoots taken off. They then proceed to fill up the hole, particular attention being paid to the small roots, which are each separately covered in. When this is finished, and the tree is considered sufficiently steady, the ropes are removed, the bars are taken out of the back of the cart, which is drawn away, and the bars having been refixed, all is ready for another removal."

The lifting power of this machine is by means of racks, pinions, and levers, as may be seen and understood from the engravings given of it.

2254. The foregoing remarks are chiefly applicable to machines adapted to the removal of large trees, weighing, with their balls, from 2 to 15 tons. In transplanting small trees and large shrubs, however, and such as with their balls may weigh from 1 to nearly 2 tons, we do not ourselves use the large and powerful machines just described, but a more simple one, in the form of a flat sledge made of thick and strong sheet-iron, supported with bars of the same material; and as we have found it very suitable for the safe removal of trees and shrubs not weighing more than two horses can drag, we shall give the specification of the one we had made, and which we are in the habit of using.

2255. The under frame of the sledge is made of three bars of iron, as represented in fig. 171. These bars are 1½ inch broad and ⅝ inch thick, and the two outer ones are made with holes at each end, as at *a*, *a*, *a*, *a*, for attaching hooks and chains for the horses dragging the sledge along. This frame is covered with the strongest description of sheet-iron, and over all is exactly 5 feet on the side of the square. The sheet-iron is of course strongly nailed to the three parallel bars; and in order to prevent the twisting of the sledge when pulled by horses, with a heavy plant on it, we have two bars of iron, of the same dimensions as the others, fixed diagonally on the upper side, and above the covering of sheet-iron, as represented in fig. 172, from *a* to *b*, and from *c* to *d*, so that when finished, this sledge, as it lies on the ground and ready for use, is exactly as represented in the figure, and, as specified, 5 feet on the side of the square. We may remark that, with this very simple mode of conveyance, we have frequently lifted and removed trees, weighing, with their balls of earth, nearly 4 tons each, and that in the most safe and satisfactory manner.

Fig. 171.

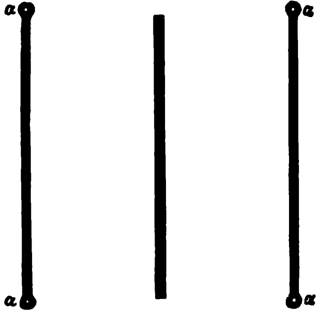
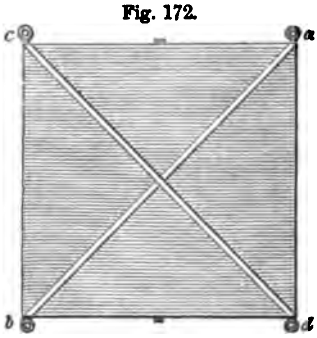


Fig. 172.



2256. At first sight it may seem that there would be some difficulty getting such a sledge put under the ball of a tree preparatory to removing it; but in practice this is not the case, as the sledge is so thin of itself, and yet so strong, that there is nothing easier than to get it under the ball as the earth is removed from it. This is managed by first undermining the ball, on the side of the hole from which the plant is to be removed, pretty deeply, and then upwards under the ball, so as to give the bottom of the hole a slight slope upwards from the point of commencement to the centre of the ball, when the sledge is put under, and other sides of the ball loosened, and then it can be easily slidden down the incline now formed by the sledge, till it is right on it. At this stage of the operation, the tree is fixed to the sledge by ropes attached to the stem, some 8 or 10 feet up, and from that point to the four holes provided in the ends of the bars of iron, and in which also the tackle for the horses is fixed for hauling. Previous to pulling the tree out of its hole upon the sledge, the earth on the outer circle should be dug away at that point by which it is intended to remove it, and of course this will be where the sledge was entered, so as to make an easy incline for the horses hauling it out. Arrived at the hole in which the tree is to be planted, it should be pulled in by an incline on the one side; and when the ropes are untied from the sledge, and the ball eased to one side by means of the ropes still attached to the tree, the sledge should be pulled out by an incline on the opposite side.

2257. In lifting large trees which have been previously prepared in the way recommended in the former section, care should be taken to open up the earth upon the outside of the light good soil which was put in about the roots,—that is, no part of that good soil should be disturbed in the act of removing the tree, but it should be retained as part of the ball; and as the young roots will have pervaded it thoroughly, it will easily adhere, and therefore can be safely removed along with the tree. In all cases of transplanting large trees, the ground should, when damp, be made perfectly dry by drainage for their ultimate success; and where the soil into which the tree is to be planted is of a heavy clay nature, the hole should be made large in proportion to the size of the ball—say from 4 to 5 feet wider than the ball—and this space should be filled up under, around, and above the ball, with soil of a medium light character, mixed with decayed vegetable mould, or with well-rotted turf mould, to the extent of nearly one-half of the whole bulk, which mixture is always found more congenial to the growth and spread of roots than a heavy soil. At the same time, it is of importance to observe that, in the case of planting trees upon a stiff clay soil, the roots should be kept proportionally shallower in the hole than if they were planted in a light soil. There is often an error committed by planting trees too deep: for our own part, we never put more than 4 inches of soil over the top roots of large trees; and even in such circumstances we have never had any disturbed by the winds, so often complained of by planters. Yet we never have used props of any kind, the weight of the ball being sufficient to keep the tree in an upright position against the effects of the weather on the top branches: this is the object gained by always removing a ball proportioned to the top of the tree, and in such a condition the trees always thrive best. In putting the soil about the roots of a large tree, when having it replanted, we have found it of immense importance to its future health not to make it as put in too compact, as is very frequently done, and which is quite inconsistent with the laws of nature. Our method of procedure in this case is as follows: When we have first about 6 or 8 inches of the soil put in about the roots in the bottom of the pit, we have it given a good watering all over, making the whole, as it were, a thick mortar. This being done, we put in another layer of the same thickness, and again another watering alternately, until the whole is filled to the surface, when we give the whole a complete beating with a heavy mallet. By this plan the water causes the particles of soil to mix intimately among the roots, which has far more effect than any tramping. When the whole is finished, we turf the surface of the opening all over at once, and give a good watering over it; the turf thus soon begins to grow, and, consequently, excludes the drought better than any other plan which can be adopted. Indeed, it is of first-rate importance, for the better security of the speedy growth of large trees when transplanted, to give repeated waterings over the surface of the ground above and about their roots, during the first four months after removal, and that more especially during very dry weather.

2258. As to the kinds of trees best adapted for safe transplanting, we conceive that any kind whatever, if previously properly prepared in the roots in the way we have recommended, may be with equal success removed. The Turkey and evergreen oaks, and also the holly, when of large size, have been considered uncertain subjects for safe removal; but by judicious preparation they may be transplanted with as much hope of success as the lime-tree or the elm.

2259. It sometimes happens, in the case of large trees that have been transplanted, that they send out shoots from the crown of the roots, and from the surface of the stem—thus at once indicating that the constitution of the subject has received a violent check; and in all such instances it will be at once observable that the top branches are not making healthy progress. In order to check this tendency, all such young shoots should be at once removed, in order to force the sap upwards; for if they are allowed to grow on undisturbed, they will appropriate a great proportion of sap to their own use as it ascends, and consequently deprive the top branches of due nourishment.

SECTION IV.—TIME OF THE YEAR MOST FAVOURABLE FOR TRANSPLANTING LARGE TREES.

2260. We have transplanted large trees of the deciduous sorts in all the months from the middle of October to the middle of April, but have invariably had the best success with the subjects dealt with in the months of October and March. Trees transplanted in the month of October, from having their roots still active, very soon lay hold on the new and kindly soil laid in about them, and in consequence sustain little or no check, and are thus at home in their sites before winter sets in; while those transplanted in the month of March, from their roots at that time being about to become active, quickly lay hold of the new soil in which they are imbedded, and so receive almost no check. Trees removed in the winter months, while their roots may be said to be inactive, do not lay hold on the soil till the following spring, and from this they are placed in unfavourable circumstances, and very often their tender fibres receive a considerable check, which retards their healthy action, and prevents the full flow of sap in the tree till late in the season, and sometimes even for a period of two years.

2261. The remarks stated above have reference only to deciduous trees. In transplanting large trees of the coniferous kinds, the operation should in all cases be performed just *when the buds are beginning to open*, and this is generally in the month of April, but may be in the beginning, middle, or end of the month, according as the particular species to be dealt with may be late or early in coming into growth, and according as the season may be an early one or a late one. We have had occasion to transplant large conifers at all times from October till the middle of May, but have invariably had the best success to attend our work in the case of subjects operated on at the stage indicated above—that is, just when the buds are beginning to open.

2262. We may state here, what we have learned from experience in transplanting large specimens of conifers, and that is—they should never be removed in autumn. When they are transplanted at this season, the winds of the following winter act so powerfully upon their heavily clothed branches as to shake the subjects from bottom to top, and thus their roots are also much disturbed, and the tender fibres prevented from settling in the soil. Hence large conifers transplanted in autumn are generally found of an unhealthy character for a year or two after, and make little or no progress till their roots have laid hold of the soil, and this they do but slowly, in consequence of the check they received during the winter after they were removed.

SECTION V.—METHOD OF RENEWING THE HEALTH OF OLD OR DECAYING TREES.

2263. As it is sometimes a matter of very great importance to those who have the management of the home-grounds of landed proprietors to know what can best be done for the preservation and improvement of favourite ornamental old trees, it may be useful to some into whose hands this book may fall, to be made acquainted with the method of adding new vigour to the impaired health of such trees. In the present section, therefore, we shall lay down our own manner of procedure in such work.

2264. Wherever it is desirable to have a tree that may be in a declining state resuscitated, or renewed in health, the first point in the operation is, to have all dead branches cut clean away, and that as far back upon each branch as to remove entirely all decidedly dead and decaying portions, till the healthy wood appears at the cut parts. Next, the stem of the tree, as well as all the larger branches, should be scraped clean from all moss that may be growing upon their surface; and all the parts scraped should be well washed down, beginning at the highest part, with a brush and cold water, observing to make the bark perfectly clean. That being done, a trench should in the next place be opened all round, cutting the roots in the same manner, and at the proportionate distance from the stem already described in treating of preparing trees for transplantation. Supposing, then, that the roots have been cut in, say 6, 8, or 10 feet from the stem all round, making the diameter of the ball of earth about the bottom of the tree 12, 16, or 20 feet, as may be necessary according to the size of the tree, exclusive of the stem itself, the trench immediately upon the outer circle of the ball should be made from 3 to 6 feet broad, and as deep as to cut every root attached to the tree down even under the subsoil, and as far as they may be found to exist, without having any respect to rule in this point. In throwing the soil out of the trench, the workmen should be instructed to lay all the good portion (which may be the upper stratum) immediately upon the outer edge of the trench opened, which will, in such a position, be ready for mixing among any better soil that is afterwards to be put in. Beyond the good soil thrown out all bad portions should be thrown, and immediately carted off, before commencing to fill in the trench about the roots again. The trench being made of proportions suitable to the size of the tree as above stated, and all bad quality of soil removed, the next thing is to have a mixture of the following kinds and proportions of soils brought forward, and which, it is presumed, has been previously in readiness for the purpose:—One part well-rotted cow-dung, two parts half-decomposed leaf-mould, and one half part powdered lime; or, in other words, to one barrow-load of well-rotted cow-dung, and two of half-decomposed leaf-mould, add one half barrow-load of lime in its powdered state, and in the same proportion whatever quantity may be required. A compound of the above description being previously prepared, and a sufficient quantity of it brought forward, have it mixed up with an equal quantity of the good portion of the soil which was thrown out of the trench, and have the opening or trench entirely filled up with this mixture; observing, in this case, as well as in the case of transplanting the large trees formerly referred to, to give plenty of water as the filling in of the new soil proceeds, and to give a moderate tramping with the feet also. When the trench has been filled to the level of the surface of the surrounding ground, have the turf, growing upon the surface of the ball between the trench and the stem, pared off to the depth of about 4 or 5 inches, which turf may be thrown back on the top of the new soil; and over all this have again about 8 inches of the compost spread over the whole extent from the stem of the tree to the outer circumference of the trench, making the ground upon that part 8 inches higher than the level of the surrounding ground; and after a good watering and tramping, the whole operation is finished.

2265. In order to encourage as healthy a state of the trees as possible, it is of great advantage to syringe repeatedly, and keep clean the bark, by means of a brush and cold water, in the summer season; and even, in the event of a continued tract of dry weather, to give repeated waterings at the roots, more especially over the new soil put into the trench, where of course the young roots will be making rapid progress. By such a system of treatment, we have seen old trees, which to appearance were rapidly decaying, recover and assume quite a renewed state. We have operated in this manner upon many fine specimens of old trees which appeared to be decaying, and which have been vastly improved by the operation; and from what we have seen in the case of subjects treated in this manner, we feel confident that the health of many old trees might again be established by attention to the mode of recovering them here described.

2266. In all cases of resuscitating old trees in the manner above advised, it is of the greatest moment to have a drain made all round the bottom of the trench before putting in the compost; for it sometimes happens, more especially if the original soil be of a heavy character, that water will lodge in the bottom of the trench; and by simply making a drain, and leading it away by a proper outlet, any danger of this kind may be prevented. If water were allowed to lodge, the tree would, instead of improving, decay more rapidly than if it had never been interfered with.

2267. In the course of our visits to landed proprietors' seats, we have seen many old and ornamental trees which could be much improved by dealing with them in the manner above detailed; and it is on this account we have given these few hints for the improvement of such. Still, in order that proprietors may not be too sanguine on the point under consideration, we may state that there is a stage of unhealthiness and old age at which trees may arrive, which will render them quite unfit for being recovered, whatever means may be used for that purpose, discrimination being necessary on the spot.

SECTION VI.—HOW HOLES AND WOUNDS IN OLD TREES SHOULD BE DEALT WITH IN ORDER TO PREVENT, AS FAR AS POSSIBLE, FURTHER DECAY IN THE PARTS AFFECTED.

2268. We often find holes on the stems of old trees standing on parks and lawns, which holes have originally been caused by wounds, as may be understood from the following consideration:—When a piece of bark has been removed from the stem of a tree, and to such a depth as to expose the sap-wood, the part thus exposed loses its vitality, and if left unprotected, decay gradually takes place. The living or uninjured wood surrounding the exposed spot will, however, begin to form new wood, and if the injury is not extensive, will in due time close over the wound; but if the damage is to a considerable extent, the exposed wood naturally tends to decay, and before the surrounding healthy parts have had time to close over it, a rotten cavity is formed.

2269. In the way stated above, rotten cavities are brought about on the stems of trees, less or more in size according to the extent of the original wound. Such holes not only cause decay in the stems of the trees affected, but are injurious by harbouring those insects whose larvæ feed upon decaying wood,—and thus the destroying process is hastened.

2270. When an old tree has been injured in the way stated—that is, when a piece of bark has been removed from its stem—no time should be lost to have the wounded part protected from the action of the air and weather. The simplest and most effectual way of doing this is to apply a coat of coal-tar to the exposed part by means of a brush. This coating will prevent the injured part from rotting, and if it is not large, and the tree in good health, it may again become covered with new wood. If the wound is large, however, its becoming covered with new wood is not to be expected. But at all events the coat of tar will prevent rot in the parts, and in consequence the formation of any cavity, and thus the preservation of the tree in a sound state.

2271. Where decayed holes are found on the stems of old trees, they should, in the first place, be thoroughly cleared of all decayed wood and other matter, and to such an extent in each case as to have the healthy wood appearing all round the walls of the hole. This done, the holes should next be thoroughly filled with coal-tar, which acts not only as a preservative of wood, but also as a preventive of insects lodging in the holes afterwards. Next, in order to prevent the spots of tar being seen on the stems of the trees, we recommend that a piece of bark, of—as nearly as possible—the same colour as that of the trees operated on respectively, should be nailed over each hole, in a neat and well finished way; and from this the trees will present no fault, but be better looking than they were before.

CHAPTER XXII.

SECTION I.—EFFECTS OF UNDERWOOD ON THE HEALTH OF TREES IN A PLANTATION.

2272. By the term *underwood* is implied bushes of a woody habit growing under timber-trees. It may consist of two kinds—namely, perfect plants of a naturally low and branchy character, as the privet, rhododendron, holly, &c.; or shoots issuing from the stocks of trees which may have been cut down in thinning, as in the case of neglected coppice. In whichever of the above forms underwood may be found in a plantation among growing timber-trees, it is capable, under certain circumstances of management, of becoming of much ultimate good or harm to the health of the trees under which it may be growing. In a plantation of considerable extent, if underwood be allowed to grow up in such a profusion as to impede a free passage of air through the trees, its effects must be of the very worst description, and must ultimately be productive of many premature deaths among them; and even those that may grow up healthily must afterwards be found inferior in the quality of their timber, from the want of a proper amount of air by which perfectly to mature the wood. On the other hand, a plantation of trees of rather small extent, more particularly if upon an exposed and high-lying situation, is much improved in health by having a well-regulated quantity of underwood growing among the trees, more especially if that is planted upon such points as are most exposed to cutting winds. But even in such situations an injudicious quantity of underwood would certainly prove injurious to the health of the trees; for let it be understood that most plants of the character of underwood naturally emit a great quantity of fibrous matted roots, which have the effect of impoverishing the soil to a great extent, and also of excluding a due portion of air from the roots of the trees under which they grow. In the introducing, therefore, of underwood into a plantation among trees which are wished to be kept in a healthy state, judicious management is required.

2273. A due proportion of well-chosen plants as underwood, is in all cases both ornamental and useful in a plantation, and may be attended with the very best effects; but an over-quantity is in all cases void of ornament, indicates confusion, and, instead of being useful, becomes a nuisance both to the proprietor in seeking after recreation, and to the forester while in the act of removing his trees. Having now merely adverted to the effects of underwood upon the health of trees in a plantation, which was all we aimed at in the present section, we shall in the next point out how underwood may be managed for the health of trees, and at the same time point out the plants best fitted for the object in view.

SECTION II.—KINDS OF PLANTS BEST FITTED FOR UNDERWOOD, AND HOW THEY MAY BE PLANTED IN A WOOD SO AS TO PRODUCE USEFUL AND ORNAMENTAL EFFECT.

2274. Having in the foregoing section made a few remarks as to the effects of underwood in plantations, and shown that it may be made to produce either good or bad effects, it still remains to be indicated how the plants generally termed underwood may be disposed of among trees so as to prove both useful and ornamental. But before doing so we shall give a list of the different kinds of plants which are known to thrive under the shade of trees, and are therefore termed underwood.

Name of Species.	Nature of Soil in which they thrive best.
Aucuba japonica,	Any loamy soil, if dry.
Laurel Bay,	Do.
Box Tree,	Do.
Dogwood,	Do.
Ivy,	Bare rocky parts.
Holly, common Green,	Rich loam.
Portugal Laurel,	Do.
Evergreen Privet,	Do.
Laurustinus,	Do.
Rhododendron,	Peat soil.
Juniper, common,	Very light sandy soil.
Yew Tree, common,	Sandy loam.
Arbor-vitæ, American,	Do.
Butcher's Broom,	Do.
Elder,	Do.
Scotch Rose,	Rich loam.
Mahonia aquifolia,	Do.
Cotoneaster, of sorts,	Any dry loam.
Philadelphus, of sorts,	Do.
Snowberry,	Do.
Spiræa, of sorts,	Do.
Hazel,	Do.
Hemlock Spruce,	Do.
Pinus pumilio,	Do.
——— inops,	Do.

2275. The above list contains the most important of the class of shrubs generally called underwood, and we have added three trees—namely, the hemlock spruce, the *Pinus pumilio,* and *P. inops*—because, from their spreading habit of growth, they are well fitted to produce excellent cover in plantations. With the exception of the dogwood, elder, Scots rose, Philadelphus, snowberry, spiræa, and hazel, the plants named are all evergreens. In planting any of the sorts named, with the view to produce shelter upon any exposed point, the elder, hazel, and pines should be used, because they are the most hardy for that purpose. Where it is wished to cover any bare rocky part in a plantation with the view of forming cover for game, and of producing an ornamental effect at the same time, the ivy, juniper, yew tree, and Scots rose should be planted, or the hazel, if considered desirable, all these thriving well on such parts; and where general groups of underwood are wanted, whether in the body of the plantations, or along the sides of the roads in them, the other sorts may be used.

2276. The common system of planting underwood is that of scattering promiscuously among the trees individual specimens, without any regard to order. To this system we object, because it is neither of an ornamental nor a useful character. We are aware that this is done with the view of producing a general cover throughout for the protection of game, but it is seldom that the plants so dealt with grow so well as either to form a respectable cover, or to be ornamental as specimens; and, besides, where underwood is found thus generally scattered over a plantation, it has more the effect of retarding and interrupting the progress of the proprietor and his friends while going through, than of adding to their recreation. We would therefore advise, as an improvement on this point of forestry, the following method, which is decidedly both ornamental and useful:—First, upon any exposed point, where it may be advantageous to have underwood grown for the purpose of producing shelter, have *Pinus pumilio* planted, say at 8 feet apart, and made up between with larch to 4 feet over all. The larch, from growing quicker than the pines, will have the effect of producing shelter to them for a few years, and thereby cause them to grow up more quickly than they would do otherwise; and as the larch advance upon the pines, the former can be thinned out and gradually dispensed with altogether. Second, where underwood is wanted in the interior of a plantation either for the purpose of cover for game or for ornament, plant groups of laurel bay, holly, Portugal laurel, hemlock spruce, and evergreen privet; keeping each kind separately in a mass by itself, to the extent of from one-sixteenth to one-eighth of an acre. Where such masses are planted, the trees should be almost altogether dispensed with, leaving perhaps only one tree in the centre of each mass of evergreens; for let it be understood, that although the plants above named will generally grow under the shade of trees, they are more likely to live long, and become bushy, healthy plants, when the trees are kept well off them. Third, at convenient intervals along the sides of the forest-rides, have groups of various sizes planted, giving these various bendings of a natural character, like plots in a flower-garden; and at well-chosen points of view from the roads have slight openings made, so that masses of evergreens in the interior of the wood may be brought into sight. In thus disposing the underwood plants into masses, care should be taken to keep all the low-growing sorts next to the rides—that is, such as the rhododendrons, cotoneasters, Philadelphus, snowberry, spiræa, mahonias, roses, laurustinus, and aucubas; and in order that a natural variety may be produced by the plants of each species being congregated in a mass, two or three arbor-vitæs may be put in as prominent plants in a group now and then, especially with the deciduous sorts, which would produce a pleasing and graceful effect; while, in some cases, a tree growing in the centre of such a group might be clothed with ivy, which also has a graceful effect in a wood.

2277. Having thus briefly stated our views as to the disposition of underwood in plantations, it yet remains for us to show the advantages of such a system over the usual way of planting them without any regard to order. Where bushes of any kind are found growing as it were at random, in a plantation among trees, they have in all cases the effect of retarding arboricultural operations, and that to a very great extent, as we have often experienced; and, besides, they have a great tendency to prevent a free current of air passing through among the trees, causing, as it were, a stagnated state of air. Now, by the system of growing underwood in small masses as we have recommended above, these bad effects are prevented; for as it is understood that these masses are to be grown at pretty wide intervals, the air will have free access to all the trees growing in the spaces between them, and wood operations can at the same time be carried on without interruption. Again, the proprietor and his friends, when in pursuit of game, can have no straggling thickets of bushes to annoy them; but when any of the covers are beat, they have open and uninterrupted spaces between each group; while the underwood, in consequence of being planted in masses, with few trees in their immediate vicinity to injure their growth, will be much more bushy, and will form a better cover than bushes scattered singly over the ground. In an ornamental point of view, the system which we here recommend is infinitely superior. By having shrubs planted singly and at random over the ground in a plantation among trees, there is a continued sameness and confusion presented to the eye; but when planted in well-defined masses, each species by itself, there may be made a continual and never-ending variety in the scene; for the eye, instead of resting upon a confused sameness, at once alights upon a beautiful and compact mass of foliage, having its outline perfectly portrayed on the space beyond among the tall trees, beyond which another mass may appear in the distance. This part of forestry is generally too little attended to, and that for no other reason than that taste is required to bring it out; but we are glad to say that this state of things is fast improving.

CHAPTER XXIII.

SECTION I.—FENCING OF PARK TREES, SO AS TO PROTECT THEM FROM DEER, HORSES, CATTLE, ETC.

2278. There are few landed proprietors' seats in Britain so perfectly adorned with all the known ornamental and useful sorts of trees, that they may not now and then receive an additional embellishment in the form of some new and highly interesting foreign species. Indeed, however complete any proprietor's home park may be as to its collection of useful and ornamental trees, if he is of a highly refined taste he will frequently take pleasure in transferring good specimens from the enclosures of his shrubberies, &c., where they were almost hidden from view, to the open parks, where they are sure to develop themselves to advantage, and prove in no small degree ornamental, by their contrast with other larger and more common sorts, when judiciously arranged among them. In order to protect such specimens from being injured by cattle that may be grazing on the park where they are planted, it is of primary importance for their future welfare that they have a fence of some sort put about them for a time at least. It is more particularly under such circumstances that we would here recommend the fencing of trees on a park; for it must be admitted that a tree growing without any protection whatever, is in all cases a more agreeable object than one having a fence about it. Wherever, therefore, it is found necessary to have single trees protected for a time from the effects of animals roaming about them, that should be done upon the most ornamental principle that can be devised.

2279. There are various methods and forms practised for the protection of single trees—from the simple wooden posts with rails, to the neat and highly ornamental, and, we may say, almost invisible, fence of iron. It would be altogether superfluous to enter into detail here upon all the variety of fences—or *guards*, as they are sometimes called—in general use for protecting single trees. We shall therefore confine our observations to the description of three sorts—namely, the octagonal, the square, and the circular.

The names, as given above, merely indicate the shape of each sort: therefore, in order to illustrate their size and general construction, it will be necessary to give a figure of each, with a few remarks subjoined, relative to how they are applied in protecting trees, the materials of which they may be made, and the expense of erecting in each case, according to strength and height.

2280. Fig. 173 is a plan of the octagonal form of tree-guard, as we have had them made for protecting very young specimens on the lawns of many proprietors; and it is an exceedingly ornamental form when well made. We make them of small larch thinnings, in the following manner:—

The tree is planted in the centre of the octagon, as shown at *a*, in fig. 173, and also at *a* in fig. 174, which last is a section of the side elevation of the plan. The open circle about the tree is marked off upon the ground about 2 feet in diameter, around which small posts are driven in so as to form an octagon in that part, as at *b*, in each figure. These posts may be from 2 to 3 inches diameter, according to the strength required, and from 12 to 18 inches high above ground. The eight small posts being driven into the ground so as to form an octagon of about 2 feet diameter, corresponding ones will next require to be driven in upon the outer circle, as shown in each of the two figures at *c c*: these may also be from 2 to 3 inches diameter, and from 3 to 4 feet high above ground, according to strength required—that is, according as there may be sheep only to guard against, or deer, &c. The octagon being formed by the posts being driven in both upon the inner and outer circles, and the diameter of the figure made, measuring from any two of the extreme points, say 10 feet, the next part of the work is to have bearers nailed on between each corresponding pair of posts, as shown in each of the figures at *d d*. These may be of the same strength of wood as the posts upon which they rest their ends. Next, a top

Fig. 173.

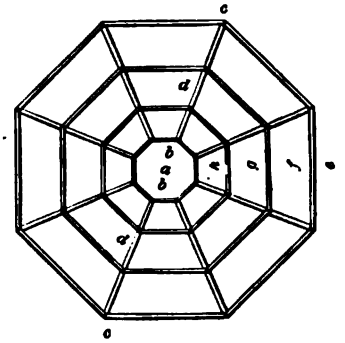
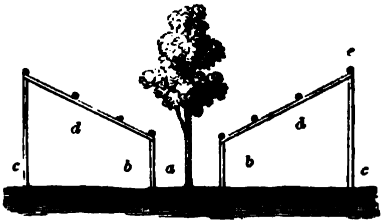
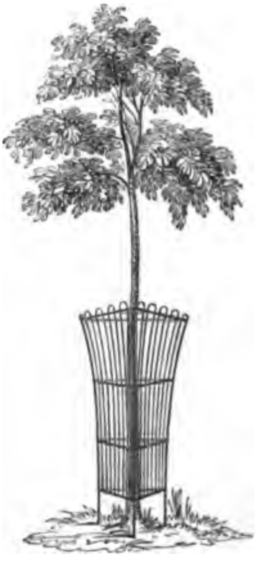


Fig. 174.



rail is to be nailed on the outer posts, as at *e e*, in each of the figures, all round, so as to bind the whole together, which top rail we shall suppose to be 2½ inches diameter. The other three courses of rails, as shown at *f*, *g*, and *h*, should be made proportionally of a smaller size as they recede downwards to the centre, which gives the work a neater and lighter appearance than if the whole were made of one dimension. In the figure above there are only four horizontal courses of rails shown; but in this matter the taste of the proprietor may be consulted, at the same time keeping in view, that if the eight spaces forming the outer boundary of the octagon are not made proof against the encroachment of sheep, the horizontal spars upon the inside slope must be made so; and also that, if it be found necessary to make the octagonal guard proof against the encroachment of rabbits, hares, &c., that is very simply attained by driving in a few extra small posts on the inner circle forming the octagon immediately about the tree. The eight squares forming the outer boundary of the octagon may be made of an ornamental character, and of any design the taste of the proprietor or his forester may suggest. As to the merits of this description of tree-protector, besides being very ornamental, it is of all others the best adapted for the admitting of free and unconfined space about a young plant,—the whole body receding from the plant, as it were, and yet producing perfect protection at the same time. We would therefore recommend it before all other forms for young specimens requiring free and open and unconfined space for the development of their branches. In parks where large cattle are grazing, the diameter of the octagon should be increased, so as to prevent them from reaching the branches of the plant; and in such a case, in order that the grass growing upon the ground occupied by the octagon may be made serviceable to sheep, it is only necessary to leave open spaces between the posts forming the outer boundary of the figure. The expense of erecting octagonal tree-protectors is but trifling; for the wood being laid down, a man will easily make one in a day.

Fig. 175.

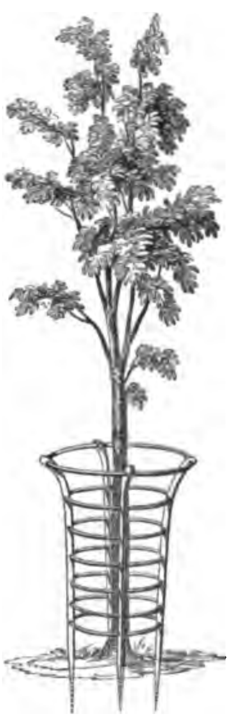


2281. Fig. 175 represents the square or four-sided form of tree-protector, which is not adapted for very young trees, but for trees of a considerable size only, and such as have a stem free of branches. They may be constructed of small larch thinnings, as in the former case, and of any convenient strength, according to the kinds of cattle to be kept back—say of wood, 2 inches diameter, and 3 feet high above ground, for sheep; and of 2½ inches diameter, and from 5 to 6 feet high, for deer, horses, or oxen. The spars may be put in all vertically, or with four uprights, one at each corner, and having others nailed on at convenient and proper distances horizontally, according as taste may suggest.

In erecting these, care should be taken to keep them at least 8 or 10 inches from the stem of the tree at any given part; for if put too close on, animals will sometimes gnaw the bark through between the spars, or strip it off with their horns.

2282. Fig. 176 represents the circular form of tree-protector, and is adapted for trees of a considerable size only, as in the case of the square form already referred to. They are sometimes made with spars altogether vertical, having a hoop to bind them together on the top, and sometimes with four or more upright posts driven into the ground, bound by hoops at regular intervals between top and bottom, as in the case of the figure here given—this, of course, being altogether a matter of taste. Both the four-sided and the circular forms of tree-protectors are of very simple construction, and may be made by any forester by means of small larch thinnings from the young plantations; and any active man will make at least six in a day. In what has been stated above relative to tree-guards, we have considered them to be made of wood only; but where a superior style is an object, they should be made of iron, painted green, so as to make them almost invisible at any considerable distance. Made of iron, they could not, of course, be so neatly done and fitted up by any forester; therefore those proprietors who wish to have tree-guards of an elegant, light, and airy appearance, we would recommend to apply to any manufacturer of iron goods, as most of them keep on hand, for the purpose, a great variety of articles of the kind, at various prices, according to strength and height, &c. The prices of the tree-guards of the square and circular forms are generally from 10s. to 30s. made of iron. The octagonal form is not, however, generally made, except to order: we have had them made lately of iron at prices varying from 60s. to 110s., according to height and strength of material.

Fig. 176.



SECTION II.—HOW TO PREVENT DEER, HARES, AND RABBITS FROM INJURING YOUNG TREES.

2283. On most estates where game is preserved to any considerable extent, there is often experienced, especially in the neighbourhood of the home grounds, great difficulty in getting a crop of young trees to succeed satisfactorily, in consequence of hares and rabbits eating their bark and young branches; and in parks kept for deer, during severe winters we have often seen these animals, if not well supplied with food, gnaw the bark from old trees, much to the injury of many fine healthy specimens.

2284. We have so frequently been asked by proprietors and their foresters as to how young trees may be best preserved from the attacks of hares and rabbits in a plantation, and as to how deer may be prevented from eating the bark from older ones, that we have devoted our attention especially to the subject, with the view of giving our experience on it in this work, and we are now prepared to state the result of such experiments as we have made.

2285. The result of the many experiments we have made on this subject may be summed up thus: That hares and rabbits may be prevented from eating the bark and young shoots from young trees by the frequent application of a mixture of cow-dung and soot, in equal proportions, made thin enough with water to admit of its being applied to the trees with a brush, in the form of a regular coating over the bark, so far as the animals can reach to interfere with it, but that the operation is so expensive as to make it desirable that the animals should be destroyed rather than incur such expenditure, at least where there is a large extent of plantation to be operated on. Where only a few trees are to be protected the case is different, and the process may with propriety be persevered in till they are so strong as to be out of danger.

2286. The mixture described is, when applied to the bark of trees, as effectual in preventing deer from injuring them as it is in the case of hares and rabbits, as we have often had occasion to prove, but the matter requires to be applied frequently in order to keep it effectual.

2287. Various other mixtures have been used for the purpose under notice, with different degrees of success, but with the exception of the one described they had all less or more an injurious effect on the healthy action of the bark of the trees to which they were applied, and therefore we in no case use them ourselves, nor recommend them to others. The mixture of cow-dung and soot we have found to have no bad effect whatever on the health of the trees to which it may be applied; and as, when frequently applied to the bark, it prevents deer, hares, and rabbits from interfering with them, we recommend it as a safe and certain preventive.

2288. Wire-netting can always be applied to prevent hares and rabbits getting into a plantation, but of course in this case the plantation requires to be entirely surrounded with it in order to keep the animals out. We have in many instances had small plantations entirely enclosed with the netting, and succeeded perfectly in preventing them getting in to injure the trees; but on a large scale this becomes expensive, and is the less likely to be successful, not being so easily looked after as in the case of a small enclosure. Wire-netting may be applied also to protect large trees from deer in a park, by fixing it round the specimens high enough to prevent the animals reaching the bark above it.

2289. Every landed proprietor who wishes to be really successful in the rearing of his plantations, should destroy the animals here referred to; as by doing this, much labour and expense would be avoided in replanting. We are glad to have it to state here, however, that many proprietors are now destroying the hares and rabbits on their estates, in order to prevent injury being done to their plantations by these animals. Were all landed proprietors to look to their interests in this way, no injury would ever be complained of in respect to their young plantations.

CHAPTER XXIV.

SECTION I.—HINTS IN REFERENCE TO THE FELLING OF TIMBER.

2290. In the sections on the thinning of plantations enough has been said in regard to the mode of felling we recommend for small trees to be removed from the respective crops, and therefore we need not again advert to that branch of the subject, but proceed to give a few short recommendations in regard to the felling of large trees, or such as may be properly called TIMBER—a designation which embraces all trees that will measure 6 inches on the side of the square, and upwards.

2291. In felling timber trees,—whether thinnings from a plantation of considerable age, or a matured crop to be cleared,—the operation may be performed either by the proprietor's own woodmen by day labour, or by a party to whom the work may be let by contract, according to the special circumstances of the case.

2292. If the timber to be felled is thinnings from a plantation of valuable and promising trees, it will generally be found most desirable to have the work done by the proprietor's own servants, and under the eye of the forester or his foreman, who are more likely to see that the felled trees do not injure the standing ones, than another and a strange party would be.

2293. When the timber to be felled is a clearance of old and matured trees, it will be found more economical to have the work done by contract than by employing men by the day; and this sort of work may be contracted for either at a certain rate per tree, or at so much for the cutting of the whole number of trees to be felled.

2294. We have often seen serious disputes arise betwixt proprietors and wood merchants, when the former sold their timber to the latter on the understanding that it was to be felled for them in a certain manner, and within a certain time; and therefore we strongly recommend that no proprietor should undertake to fell trees as a clearing for a timber merchant, as if he do, the timber merchant will, in all probability, discover ways and means to find fault either with the mode of doing the work, or in regard to the time specified, and consequently manage to have the price of the timber reduced on such a pretext. The better way, therefore, is to arrange that the timber merchant shall cut, manufacture, and carry away his trees himself, and to bind him to do the work of felling to the satisfaction of the forester, and within a given time.

2295. When the timber is sold by measurement at a certain rate per cubic foot, a proper and clear understanding should be entered into, as to—first, the allowance to be made for the thickness of the bark; second, what size of branches are to be measured as timber; third, how far out to the small ends of the trees the measurements are to be taken; fourth, the allowance to be made for any unforeseen rot or other deficiency in the trees; and, fifth, whether the branches are to belong to the proprietor or the timber merchant. On all these points we have seen very important disputes arise; and we therefore think it necessary to record the fact here, that unless, in the case of selling by measurement, the forester guard himself by previously entering into a proper understanding with the wood merchant on all these points, the latter will easily take advantage of him, and in all probability manage to make himself right in the dispute. All disputes on the points specified can, however, be obviated by selling at a certain rate per tree, or at so much for the whole lot of trees to be disposed of; and under skilful valuation we have generally found this the better arrangement for all parties.

2296. Whether timber is felled by the proprietor's own woodmen or by the purchaser, the forester should compel the parties to cut the trees as low as possible, both in order to insure the largest possible quantity of timber being realised from them, and to present an even and equal surface of the ground after the timber is removed. This can be always accomplished by clearing away from the bottoms of the trees with a spade the turf or earth that may be likely to interfere with the axe and saw in the operation of felling low, and by hewing well down with the axe all the tops of the roots standing up and projecting above the ground, and forming the junction with the stem. This should be done to such an extent that the circle of the stem of the tree to be felled shall be equal down to the earth, when it can be cut through with the cross-cutting saw in the usual way.

2297. Singular as it may seem that timber merchants should fell their trees in such a way as to leave from 6 to 12 inches of the bottom timber of each standing above ground on the stocks, still it is a fact that they generally do so when left to themselves in the department of felling their trees off root. This arises, perhaps, partly from their want of knowledge in that branch of timber manufacture, partly from their being imposed upon by the men to whom they let the work, partly from a careless habit, and partly from a desire to have the work done on the cheapest scale possible; as it must be admitted that to do the work properly, as described under paragraph 2296, the trees will cost more than when done in an opposite way. Still, we have often been surprised to see the want of foresight shown in such cases; and we refer to it in order to prepare foresters for looking after their employers' interests in this branch of forestry—as it must be kept in view that, in felling a large tree, if 6 inches of the bottom is left on the stock, this will, in all probability, lessen the value of it to the extent of the price of 1 foot of timber; which, in a plantation of some thousands of trees, will amount to a loss more than the forester's yearly salary; hence the necessity of attention to such seemingly small matters.

SECTION II.—THE APPLICATION OF WATER AND STEAM POWERS TO THE MANUFACTURE OF TIMBER.

2298. On any property having a large extent of woods, it becomes absolutely necessary to have some power or powers established for the conversion and manufacture of the timber as it falls to be disposed of; such power is obtained from machinery, propelled either by water or steam, according to circumstances.

2299. Where there is a large extent of wood to dispose of, at and approaching maturity, and where, in its neighbourhood, there is a water-run of sufficient magnitude to propel sawing machinery, it will be generally found most economical to make use of such a power, as a given amount of power is more simply and cheaply secured from the application of water to a large wheel than it is from that of steam machinery, which is always complicated, and therefore more expensive, than a simple water-wheel, both at the outset, and afterwards to maintain in perfect working order.

2300. Fixed sawing powers are, however, in many cases disadvantageous for the manufacture of timber, and this must always be the case where the several plantations on a property are each comparatively small; as, from the sawing power being stationary, there can be no great supply of timber got for it without a great outlay in carriage. When considerable distances, therefore, intervene betwixt the plantations, and where they are each comparatively small, it becomes desirable to use what may be termed a portable steam sawing power, whereby the sawing power may periodically be placed near the timber, at no great cost for change of position, instead of the masses of timber being carried to the sawing power.

2301. Whether a fixed water-power, a fixed steam-power, or a portable steam-power, should be used, will always depend upon the nature and character of the woods to be operated on, as well as upon their relative extent and position. Where the supply of wood to be manufactured is likely to keep good for a considerable number of years, where there is a plentiful supply of water, and where the carriage is not likely to exceed a distance greater than from 1½ to 2 miles at farthest, it is better to use a fixed power than a portable one; as, generally speaking, a much cheaper power can be applied from a fixed engine than from a portable one, and, besides, the former is generally more easily maintained than the latter, and less likely to get out of order.

2302. Where the plantations are each comparatively small, and where they are far apart, it will be found advantageous to use a locomotive steam-power for manufacture, which can be removed from one plantation to another as wanted.

2303. The advantages of proper sawing powers in large woods to be cut down are immense; wherever these are not provided, the price realised must be small. Where there are large tracts of wood without sawing powers for conversion and manufacture, the principal obstacle to the ready sale of the timber is the great amount of outlay necessarily incurred by the purchaser for its removal in the original rough state, and at the same time his incapacity to get rid of a great bulk of what is to him useless wood, in the form of the outer slab. Where the purchaser has the use of a sawing power on the ground where his wood is cut, this obstacle is done away with, and he can, with comparatively little trouble, relieve himself of all the valueless portion of his purchase, and at once convert it into a proper and marketable state.

2304. A very great advantage gained by the proper and judicious application, whether of steam or water power, to the manufacture of timber, is that of converting even the refuse of the trees—slabs and tops—into useful and saleable purposes, such as staves and small boards for packing-boxes.

2305. The cost of sawing powers varies according to their capability to do work. Generally speaking, however, a good fixed saw-mill, propelled by water, and of twenty-horse power, may be erected for about £500. A fixed steam-power, of similar capabilities, will cost from £600 to £700, or even more, according to circumstances; while a good portable one of similar power, with mill-sheds and machinery complete, may cost from £800 to £1500, according to the quality of the materials used in constructing it, and according to its capacity and convenience.

2306. It would, we think, be superfluous in a work of this kind to give plans and specifications for sawing powers suitable for the manufacturing of timber into the various forms in which it is used, seeing that very great improvements in the appliance of this department of machinery are taking place every now and then, and that the description of machinery which might be recommended would be adapted only to the cases of a few, and could not possibly meet the views and requirements of a tithe of my readers. We have therefore to recommend to proprietors and their foresters, who contemplate erecting sawing powers for the manufacture of their timber, to communicate with a respectable manufacturer of sawing machinery on the subject.

SECTION III.—SHOULD LANDED PROPRIETORS MANUFACTURE THEIR OWN TIMBER?

2307. The heading of this section is a question that has so often been put to us by proprietors, that we think it desirable to answer it by treating the subject of it as a separate section, and in this to record our opinion for the use of all into whose hands this work may fall.

2308. We have known cases in which proprietors who manufactured their own timber for sale, realised a greater amount from it in this way than they did by selling it in the round state to timber merchants; but for every one such case we have known ten in which the proprietors lost heavily by manufacturing on their own account, and in which they realised double the annual amount from their woodlands after abandoning the manufacture of their timber, and adopting the plan of selling it in the round state to timber merchants, who manufactured it for themselves.

2309. This will appear evident, when we point out that any proprietor, in manufacturing his own timber, must at all times be subject to the guidance of his servant who has the management of such an establishment, as it is not understood nor expected that he is either to do the work or make bargains in regard to it himself. From this it follows, that if a proprietor is so fortunate as to secure the services of a really judicious and skilful person to superintend the management of his wood manufacture, he may be able to realise the highest possible return from it; and that if he should be so unfortunate as to put the establishment into the hands of a man of an opposite character, he is sure to lose by the transaction to a very large extent, as we have very often had occasion to witness.

2310. Some time ago we were called out to inspect the woodlands on an extensive property, and, after examining them, we found them in the worst possible condition, from large quantities of comparatively young trees having been injudiciously cut down from the young and growing plantations, for the purpose of supplying extensive orders that had been received at the saw-mills, several of which were established on the property, and kept in the proprietor's own hands. The forester had the management of them, and made all bargains in respect to the sales of the timber manufactured at them, as well as directed the cutting of the trees in the woods for this purpose; and this had gone on for several years previous to our visiting the place.

2311. On further examining into the state of this establishment for the manufacture of the proprietor's own timber, we found that a large amount of expenditure had been incurred every year in the carriage of the timber from the different woods to the saw-mills, and that all the work had been done by day-labour; the result being that from several thousands of acres under valuable woods, only about £1000 per annum of clear income had been realised.

2312. As the results of this establishment to the proprietor were quite in keeping with those of many others of the same sort which we examined, we think it right to show more particularly how such establishments are generally conducted, and especially how it was that the one referred to did not result more satisfactorily than it did, which will cause the example under notice to stand out as a beacon to other proprietors who may find themselves similarly circumstanced in regard to their saw-mills.

2313. We found that the horses kept for the carriage of the trees from the woods to the mills were the proprietor's own, and fed at a high rate of expense; that they brought but light loads from the woods, and seldom wrought when the weather was wet, or such as the men with them could not work comfortably in. The men engaged cutting the trees in the woods were paid by the day; a certain number of them were kept regularly employed in this way; and they assisted in loading the carts as they arrived from the mills. In the mills we found that the sawyers were also employed by the day, that they stopped the work of sawing always when the carts with the wood arrived, in order to assist in unloading them, and that every man took the work quietly and easily as it best suited his comfort. Now, let us compare this state of things with that of another saw-mill establishment which we visited the other day, and which is kept by a timber merchant who buys timber from landed proprietors, and manufactures it upon his own account.

2314. We found that he kept no horses of his own, but contracted with a party who kept them for the carriage of all his timber from the woods to the mill, either at a certain rate per tree, per ton, or per cubic foot. He also contracted for the felling and pruning of all his trees in the woods, at a rate per tree, or per foot, and had nothing to do with the loading of the timber on the carts. In the saw-mill we found every individual striving to his utmost in his own department of the work, all the cutting up of the timber having been contracted for at a price per 1000 superficial feet, according to the thickness of the boards, &c., or at so much per sleeper, &c. &c., every part of the work being conducted in this way.

2315. The difference in the modes of working, as explained in the two preceding paragraphs, at once shows why the saw-mill establishment of the landed proprietor was so expensive, and why he did not realise so much income from it as he should have done. It was because his servants made the whole work subservient to their own comfort, and did not study his interest, but their own ease. And yet the men employed did not realise nearly such a high rate of wages as those employed by the wood merchant did; and the latter class was really more comfortable than the former. The proprietor's men had only 2s. per day, while the wood merchant's made from 3s. to 3s. 6d. each. In short, the timber merchant's establishment was conducted upon a sound and economical principle, while that of the proprietor was not; hence the former made a considerable profit from his timber, even after paying a high price for it, while the latter did not realise more than the half of the real value of his wood. This, we think, is enough to point out that, unless a saw-mill establishment be properly conducted, it is more likely to become a loss to its proprietor than a gain; and we should therefore at once give it as our opinion that proprietors, unless they can secure the services of really experienced, judicious, and efficient men for the manufacture of their timber, should on no account undertake it.

2316. We are prepared to prove that, generally speaking, it will hold true, that a proprietor of woods will realise more from them by selling his wood in the round state, than by manufacturing it himself and selling it afterwards.

2317. A proprietor having saw-mills upon his estate should let them to such timber merchants as purchase the round timber from him, at a certain annual rent. This is our own mode of going to work, and we find it the most advantageous to our employer.

2318. It is often of advantage to a proprietor that he have a small saw-mill for manufacturing such timber as he may require for estate purposes; but as this is not understood to be kept for manufacturing for sale, but merely for home convenience, the result is more likely to be beneficial than otherwise, when under the superintendence of a judicious forester.

2319. But even although the result in regard to the manufacturing of timber were to be generally otherwise to the proprietor than has been stated, we would distinctly say that where an open sale is at all times kept by a proprietor of woods, it is almost impossible for him to have his plantations reared on a right and profitable principle. When an order comes in for a certain class of wood, the foresters are sent out to procure it from a certain plantation, from which it is taken without due regard to the welfare of the crop; and it therefore follows that the crop of all the plantations so dealt with is injured to a large extent, and never afterwards comes to such an ultimate value as it would have done had it not been interfered with to supply orders. We have seen this so often done, that we here raise our voice against such a mode of dealing with plantations. We have seen, where saw-mills were kept by the proprietor for the manufacture of timber on his own account, the foresters sent out to cut trees of a certain size, from a plantation that had been thinned only one year previously, which could not be properly spared from the crop, and which ought, therefore, to have stood for other two or three years, but were wanted to complete an order. This certainly was the worst possible management; still it is adopted where saw-mills are kept by proprietors, and is one of the causes of the wretched state in which we find the woods on many properties.

2320. We shall conclude this section by remarking that few proprietors who keep saw-mill establishments on their estates are aware of the damage that is done to their plantations by their foresters taking in orders, and supplying them from such of the woods as will produce the class of trees wanted at the time. The orders are generally undertaken without much previous consideration on the part of the forester as to whether the trees are to be had without doing damage to the plantations or not; and, once undertaken, the order must be executed, and for this the trees must be cut from some one or other of the plantations, whether they can be judiciously spared or not. And the result generally is, that the plantations are searched all over for certain trees, the removal of which is generally a greater loss to the proprietor than can be made good by any value got for them at the time.

SECTION IV.—THE PREPARING OF TIMBER FOR BETTER PRESERVATION.

2321. Timber of well-matured growth, if sawn up immediately when felled, and properly seasoned and preserved from wet afterwards, will last for a great number of years; or if it be kept constantly saturated with water, it will last fully as long as when kept perfectly dry, and perhaps much longer. The best timber, however, if exposed to alternate changes of wetness and dryness, will last but a comparatively short time, as in the case of posts for fences, railway-sleepers, &c. &c. It has therefore become a matter of very considerable importance to railway companies, miners, and others who use wood to a large extent, to adopt some process of preparing their timber before they use it; and on this subject many experiments have been tried, and many ingredients used, some with considerable, and others with little, effect. As this is a subject on which there is yet a great want of correct information, and on which there is a great variety of opinion as to results of experiments, even among those who have used the same preparations for preserving their timber, we shall confine our remarks on it chiefly to our own experience, and to reliable information received from respectable parties.

2322. We have invariably found that timber, of all kinds and ages, will rot much sooner if used with the natural sap in it, than it will if seasoned, although it should afterwards be saturated with water and subjected to alternate wetness and dryness—this proving that the natural sap of any tree is a more rapid decomposer of its own timber, after its vitality has ceased to act, than common water is, and that a very considerable advantage is to be gained in this respect by drying all timber before using it, for whatever purpose.

2323. We have, in an especial manner, to call the attention of railway companies, miners, and estate agents, to this fact, that all sorts of timber, *having its natural sap expelled, will last afterwards, although subjected to wetness,* at least one-third longer than if used with the natural sap in it. This is a fact that does not seem to be understood by parties generally who use wood for outdoor and pit purposes; if it was recognised by them, we do not think they would allow their sleepers and props to be used so soon after they are cut from the trees as we generally find them, and this, of course, very much to their own disadvantage and loss.

2324. The principle of preserving timber from the effects of alternate wetness and dryness is, therefore, to expel the natural sap, and afterwards to fill, as far as practicable, the open vessels of the woody fibre with some substance known to have the effect of preserving the tissues from natural decomposition; and of course this filling up of the vessels of the wood can only be effected by their absorbing the substance to be used in the state of solution in water, or by its being forced into them by pressure. One advantage to be gained from the adoption of such a mode is, that the younger the timber, the more open is the fibre of the wood, and therefore the greater the quantity of the substance in solution which will be conveyed into the vessels; so that, if the substance used be found at all to preserve the timber to which it is applied, it will have the greatest effect on young and soft-grown timber.

2325. We know that lime is a preserver of timber, when that substance is absorbed into the vessels. The way this is done is to take *slaked lime,* or *hydrate of lime,* and mix it with water in a tank till the solution is quite thin and of a watery-consistency. Into this tank the timber should be put, after having been properly seasoned, and sawn up for the purposes for which it may be wanted. It should be allowed to lie in the solution for a number of days, in proportion to the scantling to which the timber is cut. If the scantling is small, such as boards, it may have absorbed enough in seven days after being put into the tank; but if somewhat large, it may require fourteen days; and if large, even twenty days may not be too much.

2326. As soon as the timber has been long enough in the tank to allow of sufficient absorption, it should be taken out, and afterwards so thoroughly dried as to expel all the water from it, when it can be applied to use. We have seen timber treated in this way last upwards of twenty years as a fence.

2327. Common salt is also a preserver of timber. For this purpose it is dissolved in water in a tank, into which the timber is put to steep, in the same way as described in reference to the lime solution; with this difference, that as the salt held in the water enters the vessels of the wood much sooner than the lime does, they will be generally found filled with the salt solution in about half the time specified for the other solution.

2328. That salt is a preserver of timber has long been experienced by the timber merchants who live at Garemouth, on the sea-side, at the mouth of the Spey. To this place large quantities of timber are floated down the Spey from Strathspey; and it has long been remarked by the inhabitants of Garemouth, that the timber which lies longest among the salt sea-water, after it is floated down, is that which is most likely to last long for any purpose afterwards.

2329. For the better preservation of the timber which we use ourselves in many of the works with which we have to do, we use a recipe which we got from, and which for many years has been used by, a landed proprietor with whom we are acquained, and which he has found to answer well in the preservation of such timber as he uses for fencing purposes. The recipe is this:—

The ingredients used and their proportions are—

1 lb. sulphate of copper.
1 lb. sulphuric acid.
6 gallons of water.

Directions for mixing for use:—Dissolve the sulphate of copper in 1 gallon of boiling water, then add 5 gallons of cold water; mix well, and then add the sulphuric acid—common strong oil of vitriol.

Following these proportions, any quantity of the mixture may be made. In using it, the tank should be filled to about one-third of its depth, when the timber to be steeped for preservation should be laid in it in a regular manner.

2330. The timber should be well seasoned before it is put into the tank. Twenty-four hours is sufficient for the steeping of timber of small scantling, and large scantling in proportion. By steeping timber in this mixture it will last nearly double the time it usually does when used without such steeping.

2331. Mr George France, agent on the estate of Glenelg, in Inverness-shire, prepares all the timber he uses for fencing and other outdoor estate purposes in the following way: As soon as the timber is felled in the woods, he has it manufactured into post or other scantlings, as may be required. These scantlings are next stored past into a covered shed, which is left open on the sides and ends to admit of a free current of air. In this shed the pieces of wood are built in such an open and regular way as to admit of a current of air passing freely through among the whole of them; and, generally speaking, by the end of eighteen months, all the timber thus exposed is found to be well seasoned, and therefore fit for use. Before using it, however, even for putting up a common paling, Mr France has it painted with *Croggon's black varnish,* in order to prevent wet from getting into the vessels of the wood after it is exposed to the action of the weather; and by this simple process he has fences which were erected many years ago, still as good as when they were first put up. This, then, is a mode of preparing wood for better preservation worthy the attention of every forester; and as it is a cheap one, any forester has it in his power to put it to the test of his own experience.

2332. The grand secret of preserving timber is first to have its natural sap thoroughly expelled—and this can be well effected by cutting up the tree as soon as it is felled into the scantlings it is wanted for—and then to lay it past in an airy but covered shed, there to lie for at least eighteen months. When the sap has been thus expelled from the wood, it should next be either steeped in the mixture referred to under paragraph 2329, or painted with Croggon's black varnish, both of which seem to answer the purpose equally well, so far as we have seen the results of them; the principle being, in both cases, to prevent wet being absorbed into the vessels of the wood after the natural sap has been drawn out of them.

2333. We here repeat what has already been inferred, that were railway and mining companies, as well as foresters, to attend to the simple process of thoroughly seasoning the timber they use, and afterwards deal with it in one or other of the ways stated before exposing it to the action of alternate wetness and dryness, a vast saving to the interests of all concerned would be the result; for if we can make sleepers or posts last twenty years instead of ten, this would be a saving of 100 per cent on these items alone.

2334. We may here refer to a mode of preparing timber for better preservation, which is adopted in North America: it is this:—The timber is first cut up into the scantlings it is wanted for, and then laid past in an airy covered shed, there to lie till the natural sap is thoroughly expelled. When the scantlings are thoroughly dried, they are put into a tank contining *creosote*, or what is known in North America as *dead oil*. In this the timber is allowed to lie till it is saturated with the liquid, when it is taken out for use. Timber dealt with in this way is said to last many years for outdoor purposes, and as sleepers for railways.

2335. The preservation of wood is indeed a national question with all civilised people at the present day; for where is the supply to come from some fifty years hence, seeing that the railway and mining operations of each country are steadily on the increase, and consequently the demand for this material? It is said that France and Britain alone use annually considerably more than 20,000,000 cubic yards of wood; and seeing this, it becomes us to endeavour by every means in our power to lessen this demand by preparing the timber we use so as to make it last longer than it has done; for it is clear that if in future we can make our timber last twice as long as it has done in the past, the one-half of the quantity now used could be made to answer the same purposes.

2336. Iron, it is true, is now much used instead of wood for many purposes; but notwithstanding this, the demand for wood is still upon the increase, and this arises chiefly from the extension of our mining and railway systems. It is therefore chiefly to the managers of these great branches of our national industry that we must look for economy in the use of wood; but so long as they continue to use their wood without its being first properly seasoned, we cannot hope for the demand being less than it now is.

SECTION V.—WEIGHT OF DIFFERENT KINDS OF TIMBER, BOTH IN THE ROUGH AND MANUFACTURED STATE.

2337. The comparative weight of the different sorts of timber is a branch of forestry which has hitherto received too little attention from those engaged in it, and from this cause many miscalculations have been made by foresters in reference to the carriage of wood, as well as in reference to the quantity of manufactured timber that a certain number of trees, of a given size, should turn out.

2338. We are now, however, put in possession of such an amount of knowledge on this subject, as will prove highly instructive and useful to all interested in it; and for this we are indebted to Mr Rait, forester at Castle Forbes.

2339. The tabular statements which follow in this section have been given us by Mr Rait, and we shall give these statements as they were received from that gentleman, and make our remarks upon them, in explanation of the different points they embrace. The following is the first of these tables:—

', Scots Pine, and Larch Dry States.

	Scantl			Sapwood.			
'ubic Feet on.	Weight per Cubic Foot.		'eet	Weight per Cubic Foot.		Number of Cubic Feet to a Ton.	
Dry.	Green.	Dry.	.	Green.	Dry.	Green.	Dry.
	lb.	lb.		lb.	lb.		
85	47-54	27⅓-28 5/16	2	62 7/16-63	26-27	35½-35⅞	83·86⅙
71½	39½	33⅛	½	62 7/16	34⅞	35⅞	64⅕
...	52⅔	27¾	¾	61	28	36⅔	80
...	58¼	30 7/16	¾	63	29¼	35½	76½
74	55⅝	28		...	...	...	...
75¼	55⅔	30½		...	...	...	...
68⅖	49	32½		...	...	...	...
...	43¾	29 44/64		48	32½	46⅔	69
57⅖	46⅛	34 29/32		...	...	...	...
78⅓	39½	28¼		...	...	...	...

AND WEIGHT.

'Cubic Feet to a Ton.	lb.	lb.	'eet on.	lb.	lb.	Cubic Feet to a Ton.	Cubic Feet to a Ton.
71½-85	39½-54	27⅓-33⅛	2	61-63	26-34⅞	35½-36⅔	64⅕-86⅙
68⅖-75¼	49-58¼	28 32½	¾	63	29¼	35½	76½
57⅖-78⅓	39½-46⅛	28¼-34 29/32		48	32½	46⅔	69

by twice the length. This rule has be-sawn boards would approach each other.

2344. Having given this tabular statement, we shall now make some remarks in explanation of it; and in the first place we may observe, that the table is divided into two great heads—viz., 1st, the weight of spruce fir, Scots pine, and larch timber, per cubic foot, and the number of cubic feet to a ton weight of each sort, in the rough or unmanufactured state; and, 2d, the weight per cubic foot, and the number of feet to a ton weight, both in the green and dry states, of the same sorts of wood, but manufactured.

2345. Beginning at the left-hand side of the top of the table, and reading the headings of the different columns, it is observed that the weights of the different kinds of timber experimented with are given both with the bark on and with it off. This is a great advantage, as in the carriage of such unmanufactured timber it is always desirable to know the weight of it both ways.

2346. Passing the headings in reference to the unmanufactured timber, the eye next glances over the different columns in reference to the weight of timber in the manufactured state; and here we find that this is given both in the green and dry state, per cubic foot, and the number of cubic feet to a ton, both in the green and dry state. These details are given in regard to boards and scantlings, as well as to the heartwood and sapwood of each sort respectively.

2347. It will be interesting to compare some of the results of the experiments as brought out in paragraph 2340, in reference to the weight of the spruce fir. Here, in the first column, it is shown that the ages of the timber experimented on are from 35 years to 90 years; while, from the third column, it is brought out that the timber of the spruce fir, with the bark off, is, as nearly as possible, of the same weight ($69\frac{7}{8}$ lb. per cubic foot) from 35 to 50 years of age; but that when it is so old as 90 years, it becomes as light as 57 lb. per cubic foot. This of itself is a fact worth much to those who deal in such timber, as it is at once an evidence that the older this wood is the lighter it becomes, and therefore can be the more cheaply carted.

2348. Passing on to the seventh column, we remark that the number of cubic feet to a ton of the spruce-fir timber, without the bark, is as nearly as possible the same at 35 and at 50 years, being $32\frac{1}{16}$ and 32 respectively; while, when the timber arrives at 90 years of age, it is shown that it requires $39\frac{1}{3}$ cubic feet to make a ton weight.

2349. Let us for one moment compare the weight of the heart and sap wood of the spruce fir. Passing along to the right-hand side of the table, we observe that 1 cubic foot of the heartwood of spruce fir, in the dry state, and at 35 years of age, weighs $26\frac{3}{4}$ lb.; while at 50 years of age it varies from $24\frac{11}{32}$ to $28\frac{23}{32}$ lb.; and that at 90 years of age it generally weighs 28⅛ lb. On the other hand, 1 cubic foot of the sapwood, in the dry state, and at 35 years of age, weighs 28 lb.; at 50 years from 26 to 27 lb.; while at 90 years it weighs 34⅞ lb.: thus showing that at all stages of the growth of the tree the sapwood is considerably heavier than the heartwood.

2350. The results noted under paragraph 2341, in reference to the weight of Scots pine timber, are given on timber of 60 and of 100 years of age; and as the figures speak for themselves, we need not lengthen our remarks on them, as the reader can examine them, and note comparisons himself,—the remarks just made in reference to the spruce fir serving him in some degree as a guidance in such comparison.

2351. The experiments noted under paragraph 2342, in regard to the weight of the timber of the larch, are of a more limited character than those of either of the other two kinds, they being confined to trees of 60 years of age. Still, so far as they go, they are highly useful. They show that the weight of a cubic foot of larch timber, in the round state, and from a tree of 60 years of age, and with the bark off, varies from 61 to 69 lb., and that from 32½ to 36⅔ feet are required to make a ton weight.

2352. In examining the results brought out in this table, the RANGE OF AGE AND WEIGHT, as given under paragraph 2343, will be found very useful for a comparative glance of the whole. We shall next give a table in reference to the weights of the commoner sorts of hard-wooded trees. It is as follows:—

TABLE showing the Weight of Oak, Ash, Elm, Beech, Birch, Plane, and Horse-Chestnut, in the Round and Manufactured, Green and Dry States.

	In the Round or Unmanufactured State.						No. of cubic feet to a ton.	In the Manufactured State.					
	Species of Tree.	Years Planted.		Girth in inches.	Comparative weight in pounds of a piece with and without bark.	Weight per cubic foot in pounds.		Where cut from.	Dimensions of sections.	Weight per cubic foot.		Cubic feet to a ton.	
										Green.	Dry.	Green.	Dry.
									ft. in. in.	lb.	lb.		
2353.	Oak, . .	100	Bark on Bark off	32½ 30	35 31½	90 81	24⅞ 27⅝	Heart of Log Sapwood	1 3 × 2 1 3 × ¾	69 62¼	53¼ 41	32½ 36	42 54⅝
2354.	Oak, . .	52	Bark on Bark off	27 24¾	24$\frac{34}{58}$ 22⅛	93$\frac{9}{32}$ 83¼	24 26$\frac{11}{12}$	Heart of Log Outside	1 3 × 2 1 3 × 2	73⅛ 67⅕	50⅝ 48	30⅔ 33⅓	44⅙ 46⅔
2355.	Ash, . .	52	Bark on Bark off	38¼ 36	41$\frac{1}{16}$ 36⅞	73 65½	30$\frac{5}{7}$ 34⅕	Heart of Log Outside	1 3 × 2 1 3 × 2	51¾ 53¼	42 42⅝	43¼ 42	53⅓ 52$\frac{4}{7}$
2356.	Elm, . .	70	Bark on Bark off	27¼ 25¼	21⅛ 18¼	76 65½	29½ 34⅕	Heart of Log Outside	1 3 × 2 1 3 × 2	53⅗ 54¾	37½ 38⅝	41¾ 41	59⅔ 58
2357.	Beech, . .	70	Bark on Bark off	36 35	44$\frac{7}{16}$ 42$\frac{5}{16}$	84$\frac{3}{16}$ 80⅛	26⅗ 28	Heart of Log Outside	1 3 × 2 1 3 × 2	63⅝ 64⅛	46½ 45¾	35⅕ 34⅞	48⅙ 49
2358.	Birch, . .	70	Bark on Bark off	38½ 34¾	43⅛ 37$\frac{5}{16}$	82¾ 71⅝	27 31¼	Heart of Log Outside	1 3 × 2 1 3 × 2	58½ 57⅜	40½ 42	38¼ 39	55⅓ 53⅓
2359.	Sycamore, .	52	Bark on Bark off	39¾ 37¼	52$\frac{5}{16}$ 47	87$\frac{9}{16}$ 78$\frac{11}{16}$	25$\frac{4}{7}$ 28$\frac{3}{7}$	Heart of Log Outside	1 3 × 2 1 3 × 2	62¼ 63¾	43½ 46⅝	36 35⅐	51½ 48$\frac{1}{7}$
2360.	Horse-Chestnut,	52	Bark on Bark off	38½ 36½	40$\frac{3}{16}$ 35$\frac{13}{16}$	69$\frac{17}{32}$ 61⅜	32⅕ 36½	Heart of Log Outside	1 3 × 2 1 3 × 2	52⅛ 53¼	32¼ 33	43 42	69½ 67⅞

2361. Having said so much in explanation of the tabular statement in reference to the weight of the fir, pine, and larch, it is not necessary that we should make any lengthened remarks in explanation of the one just given in regard to the hard-wooded sorts of timber, as its figures speak clearly for themselves from the way in which they are arranged; and the reader can see at once what is represented by the different columns, from the headings written on them.

2362. With special reference to the experiments set forth in the table just given, we may point out their advantages to all engaged in manufacturing timber. For example, opposite to paragraph 2353 it is shown in the fifth column from the left side that, generally speaking, if a piece of oak of 100 years' growth weighs 35 lb. with the bark on, it will weigh only 31½ lb. after the bark is taken off it. In the sixth column it is next shown that 1 cubic foot of oak, of the age stated, weighs 90 lb. with the bark on, and only 81 lb. with it off: thus showing the weight of bark that may be expected from such timber, per cubic foot, in the green state.

2363. We shall now compare the weight of a ton of this class of timber, as it is shown from these experiments, both in the round and in the manufactured states, and in the green and dry states also. It is stated in the seventh column, and opposite to oak of 100 years, that, with the bark off, 27⅝ feet make 1 ton (this is, of course, in the green state). From this, then, it is shown that a timber merchant, in removing such timber, could only take about this number of feet on one horse as a load: thus proving the great advantages resulting from the manufacture of timber on the spot, as it is further shown, in the twelfth column of the paragraph referred to, that after the same timber is manufactured, and although in the green state, no less than from 32½ to 36 feet of it can be taken on a horse, as 1 ton weight: thus making a difference of 7 feet to the ton, on the average, in favour of the manufactured timber. But a still greater difference is obtained by having the timber properly seasoned before it is removed to a distance. This is shown in the two last columns in reference to the oak of 100 years; for in them it is stated, that although from 32½ to 36 feet of the manufactured timber may be taken as a load, of 1 ton weight, while the wood is in the green state, when it has been dried, no less than from 42 to 54⅝ feet can be taken. These are facts worthy the notice of all interested in the cutting down and manufacture of timber, and we therefore recommend our readers to study well, in these respects, the bearing and results of both the foregoing tables, in reference to the results they represent on all the kinds of timber detailed in them, whether pine, fir, larch, oak, or other hardwoods.

2364. Having made the foregoing remarks on the character and tendency of the information contained in these tables, we need not add more in regard to them, but state our hope that foresters generally will set about making similar experiments for themselves, as to the weight of the different kinds of timber per foot, and the number of feet required to make up a ton, both in the round and in the manufactured states, &c., in the different parts of the country.

2365. In making such experiments, however, it would be well to improve on the subject of these tables, as however good they may be at the present stage of our information on the subject, much useful information might be added in taking up and studying the subject systematically. For example, in making experiments in regard to the weight of the timber of any particular kind of tree, it would be an improvement to state the character of the land on which it grew, its aspect, whether a hill-side or a flat, the elevation above the sea, whether the land had been drained, or was naturally dry, the exact age of the tree on which the experiment was made, its dimensions, and whether it grew in a crowded plantation, &c. &c.

2366. We have reason to know, from our own observations on this subject, that the weight of any given kind of timber is much influenced by the nature of the land on which it grows, by the aspect of the situation, as well as by the absence or presence of much direct sunlight on the stems and branches, and also by the coldness of the subsoil from wetness. To make complete and satisfactory experiments on this very interesting branch of forestry, therefore, all these points should be kept in view by the experimenter; and, if possible, the experiments should be made on each kind of timber, at all ages, from 10 years old up to 100 years.

CHAPTER XXV.

SECTION I.—THE ESTATE REGISTER OF WOODS AND PLANTATIONS.

2367. It is a remarkable fact in the arboriculture of Great Britain, that on very few estates in the country is there any register kept of the condition, age, kinds of trees, and present value of the crop of each plantation.

2368. Every merchant, whatever he may deal in, draws up at the end of each year a statement showing the marketable value of the goods he has on hand from the trade of the previous year; and from this and his realised money matters together, he is at once enabled to see whether his estate is increasing or decreasing in value; and in consequence he is enabled to shape his way in business for another year. Every intelligent farmer acts on the same principle; and at the end of the year, after his crops have been all secured, draws up a statement showing the value of his crop and stock; and from this he also is able to see at a glance whether his business is improving or otherwise. The landed proprietor, however, is not generally so particular in taking a value of all his goods at the end of each year: it is true, indeed, that his agent is always able to show him the clear income from the farming and mining interests of his property, and also that realised from his woods and plantations for the year; but as to taking a correct account of the real value of the latter department as it stands upon the estate, that is seldom or never thought of. This is a great mistake in the management of landed properties, and, as an improvement in this respect, we have to suggest that every landed proprietor should have a register of his woods and plantations, embracing the following heads:—

2369. 1st. The extent of land—stating each particular plantation—occupied by plantations of less than 5 years' standing; stating the kinds of trees planted in each district respectively, the condition of the crops, and their present market value as a commodity on the estate.

2d. The extent of land occupied by plantations of 5 and under 10 years' standing; showing the age and kinds of trees planted in each district embraced, the condition of the crops, when they may be expected to require thinning, when they will begin to yield profitable returns from the sale of produce from them, and also their present market value.

3d. The extent of land occupied by plantations of 10 and under 15 years' standing; showing the age and probable number of trees of each kind embraced, and in all, the number that will fall to be removed at each periodical thinning, and their value, together with the condition of the crops, and their present market value.

4th. The extent of land occupied by woods and plantations of 15 and under 20 years' standing; showing the same particulars in respect to each district embraced as described under head No. 3.

5th. The extent of land occupied by woods and plantations of 20 and under 30 years' standing; showing the age and number of trees in each plantation embraced, the number that will fall to be removed at each periodical thinning, and their value, together with the general condition of the respective crops, and their present market value.

6th. The extent of land occupied by woods and plantations of 30 and under 40 years' standing; showing all the particulars in regard to crop of each district as stated under head No. 5.

7th. The extent of land occupied by woods and plantations of 40 and under 50 years' standing; showing all the particulars in regard to the crop of each district as described under head No. 5.

8th. The extent of land occupied by woods and plantations of 50 and under 60 years' standing; showing the particulars in respect to the crop of each district as stated under head No. 5.

9th. The extent of land occupied by old and matured trees; the age and number of each kind on this, the number of trees in all, and their estimated probable value.

10th. Value of trees growing on the park, with that of each specimen separately; showing those that were healthy and still improving, and those that were matured, together with the age of each specimen.

2370. Any proprietor of woods in possession of such a register of them as is indicated in the foregoing paragraph, and that carefully and correctly drawn up, would at any time be able to ascertain the precise value of this department of his property; whereas, without it, the value of his woods is always a subject of mystery to him,—something he never can understand nor know how to calculate upon. Such a document as this, in regard to the woods on an estate, would give the proprietor a clear and reliable insight on the subject of his woodlands, and would enable him to deal with them in such a way as to be prepared to see whether his forester dealt fairly with him in respect to that branch of the rural economy of his estate. In short, with such a register drawn up every year as an account of timber stock, the proprietor would know how many trees were, or ought to be, in each plantation on his estate, their value separately and aggregately, whether for the present or in a prospective point of view; while, at the same time, he would always be able to judge himself as to the amount he ought to realise from his woods and plantations in each year, and would not be dependent on his servants for such information.

2371. We have of late drawn up several registers of the plantations on estates, on the general principle here explained, and they have given the greatest satisfaction to the proprietors; inasmuch as they are now in possession of information in regard to their plantations which enables them to deal with them in a clear and intelligent manner, in whatever way the subject may be viewed, which they could not do before; and it is from knowing that few proprietors are in possession of such knowledge in regard to their woods that we here refer to the subject; for until proprietors make themselves thoroughly acquainted with the real value of their woodlands in the way that we have pointed out, they cannot be expected to take that interest in them which their importance on the estate demands at their hands.

2372. In this department of forestry the Germans are highly intelligent, as all of them who have woodlands keep correct accounts in respect to the trees in each of their several plantations, and from this they are able at any time to refer to the value of a tree in any particular plantation, to the value of any plantation as a whole, or it may be to the value of their plantations in the aggregate. We admire the intelligence and skill of the German foresters in respect to the point under notice, and are desirous that British foresters should be as much so.

SECTION II.—REPORTING ON WOODLANDS.

2373. It seems to us that the reporting on the condition of, and as to the best mode of dealing with, the plantations upon estates, by some one known to be well skilled in the management of woodlands, is too little attended to by their proprietors; as, if it were otherwise, and judicious instructions properly carried out, we should not find so great a part of the woodlands of Britain in the unprofitable state in which they are.

2374. In travelling through both England and Scotland, we find the plantations on many estates still in an unthrifty condition, and on inquiry as to whom they belong, we almost invariably find that they are in the hands of comparatively small proprietors, who keep mere workmen to look after them, who can fell trees when required, or measure them for sale, but who know very little of forestry, properly speaking. Can any other result be expected from such men than that the plantations over which they look should be in an unthrifty state? Can any proprietor expect that a man who is content to work in his woods for the wages of a labourer, should be as good a forester, and as profitable a one, as one that would not serve him under three times that amount?

2375. In forestry, as well as in all other branches of business, men are paid according to their ability; and it is in large establishments that we find men of large abilities. This statement is applicable generally, for there are sometimes exceptions; but in the common nature of things this will be found to hold good, and especially in regard to forestry, and the sister branches of rural economy.

2376. At this stage of our remarks on the subject, the question very naturally arises, How, then, should small proprietors conduct themselves in regard to their foresters, since the extent of their woodlands will not admit of them employing men at a salary beyond what the income from their plantations will justify, in the general management of their properties? Our reply is, A skilful man is always a more profitable one, in any business whatever, than one of an opposite character, all circumstances alike.

2377. In illustration of this we may remark, that if a landed proprietor has 500 acres of woods, he would, without doubt, realise a greater annual income from them by putting them into the hands of a man as forester at £100 a-year, than he possibly could were they in the hands of one at £50; inasmuch as the man at £100 of salary would be—or at least ought to be—able to bring a greater degree of intelligence to bear upon all his operations than the other.

2378. On this point all the difference lies betwixt the profitable and unprofitable management of anything. In the very mode of going about the labour of woods, an intelligent forester will save a large percentage of expenditure compared with one who is not so, independent of the fact that the one is also able to make better and more profitable sales of the produce than the other,—thus enabling his employer to pay him a higher salary than he could to the other.

2379. We have seen this exemplified in so many cases during our experience in the last thirty years, that we strongly urge every proprietor of woods either to secure the services of an intelligent forester, or keep none at all, in the common sense of the word, but a mere labouring woodman, to act under the directions of another.

2380. We could give many examples in illustration of the reasonableness of this recommendation; but we shall content ourselves with one. Some time ago we were called out to inspect the plantations upon an estate, and asked to give our report on them for the future guidance of the forester. The plantations in all extended to about 350 acres, and were of ages varying from 15 to 50 years, with groups of hardwoods of greater age in the neighbourhood of the mansion-house. From the death of the proprietor, the heir of the estate had been in minority for some ten years, and during all that time little or no thinning had been performed for the welfare of the plantations, either in the younger or the older ones; so that, as a whole, we found them in a very unsatisfactory state indeed. Generally the crops—except on some partial spots, where trees of some size had been cut for estate purposes—were drawn up and weakly.

2381. In our survey of the plantations we were accompanied by the man called the forester, who had been, and was, a mere feller of trees when wanted for estate purposes, and who indeed knew the one sort of tree from the other, but had no definite idea of the advantages of thinning or of draining to the health of the trees that had been nearly twenty years under his care; and the result of this was, the unsatisfactory state in which we found the several plantations. We learned from him that the late proprietor had taken the principal charge of the woods himself, for the purposes of recreation and amusement; that he marked himself the trees that were to be removed as thinnings, and that the forester had only to fell such as he marked. There was, indeed, evidence of this in the condition of the several crops, as they seemed to have been well thinned at one time.

2382. Here, now, was a case of mismanagement in plantations, from the want of intelligence in the man placed over them as forester; and one that clearly shows the great loss that proprietors, in a number of cases, sustain by leaving their plantations in the hands of unqualified men. But more specifically, here was a case in which we found the plantations which, had they been properly attended to, at their age ought to have had a crop worth on the average some £40 per acre, not worth the half of this, and which, prospectively, had been rendered of comparatively small value.

2383. What we wish to infer from the foregoing is, that it would have been vastly more advantageous for this property, had those in whose charge it was left paid several hundred pounds to a well-qualified forester per year, than to have left the woods in the hands of the man they allowed to remain in charge of them, and from whose simple ignorance the plantations had been comparatively ruined.

2384. As we found the forester then resident on the estate incapable of carrying out our recommendations for the improvement of the plantations, and saw that the income likely to be derived from them would not, at least for a number of years, well allow of a first-rate man being constantly employed in them, we recommended that an expert woodman should be engaged to superintend the labourers engaged in the different works of thinning and draining as they fell to be performed, and that an experienced and highly-qualified man should be called in to mark the trees to be removed as thinnings, and to attend to lay off drains, and give general specifications and instructions, consistently with our report on the subjects, from time to time, as the different works required attention.

2385. This case explains the meaning of the statement made in paragraph 2379, that "we strongly urge every proprietor of woods either to secure the services of an intelligent forester, or keep none at all." We have recommended the same mode of procedure—with a common woodman headed by an intelligent forester from time to time to whom he referred in all cases of seeming difficulty—in regard to the woods on many small properties we have visited, and where the proprietors were not so much interested themselves in the management of their woods as to induce them to see the points of our report carried out; and in all cases it has given the most entire satisfaction.

2386. By adopting this mode of managing the woods on small properties, on which a highly-qualified man could not be constantly maintained, the woodman, who is of course a mere workman over others, if necessary, is in no way trusted with the management of the woods, but only works under the directions of the qualified man, to whom from time to time he looks for guidance, and whose check for badly performed work, or approval for well performed, keeps him at all times at his duty, in order to see that matters are in proper order for inspection when his superior calls upon him.

2387. Having made these preliminary remarks on the subject of the management of woods on those small properties where a properly qualified forester cannot well be profitably maintained, we proceed to describe how the reporting of woodlands should be dealt with generally, for the guidance both of the proprietors themselves and of the persons in charge of their woodlands. We might have entered on this at once, without any of these preliminary remarks; but we thought it better to refer, in the first place, to the bad state in which plantations on small properties are often found, in order to bring out more clearly the great necessity there is for every proprietor being furnished with a report on the management of his woods, by some intelligent and skilful man in his profession; as, without such a report, the works of thinning, draining, &c. &c., can never be carried out systematically, nor the income realised, with that degree of profit or satisfaction which the proprietor has a right to demand of the person into whose hands he gives the charge of his woods.

2388. In the management of woods, as well as in that of any other branch of business, unless a definite and suitable class of rules and regulations be laid down, adapted to meet the nature of the subjects, the whole business gets into disorder; transactions, whether in regard to income or expenditure, result unsatisfactorily, and from this the business becomes unprofitable to its proprietor. To obviate such results in regard to the management of woodlands, is the object of judiciously reporting on them.

2389. In reporting on the woodlands of any estate, the following SEVENTEEN HEADS should be laid down by the reporter as a groundwork for his subject:—

1st, A tabular statement showing the extent of the woodlands on the property, stating the ages of the several crops.
2d, The present condition of the crop in each separate plantation, stating the average diameter of the trees in each case.
3d, The nature of the past management under which the plantations have existed.
4th, How far the several crops had been properly suited to the different descriptions of land planted, stating the geological character of the soil.
5th, The plantations which have made most progress at their respective ages, and the circumstances which have contributed to this state of the trees.
6th, Those which are unhealthy or diseased, and the cause of this.
7th, The particular system of forestry that should be adopted for the improvement of the plantations generally.
8th, General recommendations and specifications in regard to fencing.
9th, The same in regard to the operations of drainage.
10th, The same in regard to replanting of unoccupied spots in the existing plantations.
11th, The same in regard to the planting of new enclosures.
12th, The same in regard to the mode of pruning suitable for the several crops.
13th, The same in regard to the operations of thinning.
14th, The income which, under good management, may be annually derived from the plantations.
15th, The expenditure which, in all probability, will be annually required to carry out the improvements suggested, and to maintain the woodlands in proper condition.
16th, How wood sales ought to be conducted on the property, taking the situation of the plantations, and their distance from market, into consideration.
17th, Statement showing the probable income that may be derived from each plantation during the next ten years.

2390. Having given the foregoing seventeen heads as the points which should be specially attended to by any one who would undertake reporting on plantations, whether of a small or large extent, we shall next devote one paragraph to a short description of the manner in which the reporter should take up and illustrate each of them for the full benefit of the proprietor and his forester.

2391. In taking up the subject of the 1st heading, the reporter should be careful to make his tabular statement as comprehensive as possible, and he should at least embrace in it the following points, each of which should be stated under a separate column: viz.—the name of each plantation; the nature of the underlying rock; the character of the soil and subsoil; the condition of the land previous to its having been planted; the extent of imperial acres; the character of the crop; its age; description of fence by which surrounded; and elevation above the sea.

A well-arranged statement of this sort will form a history of each plantation, and will be found of great use both to the reporter himself, while he is engaged in the work of reporting, and to the proprietor and his forester afterwards.

2392. With regard to the 2d head, the reporter should prepare himself, by a careful examination, to give a particular account of the state in which he finds the crop in each plantation, attending particularly to note the state of the trees, as he finds them affected by crowdedness or thinness, and by wetness or dryness, &c. &c. He should also note the state of the fences on each separate enclosure, the extent of drainage necessary to improve the crop, and the probable value of the crop of each, both at present and prospectively.

2393. As to the 3d head, he must be careful, as he proceeds, to note in reference to the health of the several crops, and state whether the trees are suited to the land they occupy, and whether they are likely to arrive at much value upon it.

2394. The subject of the 4th head can, of course, be drawn from the general tone of the notes taken in reference to the plantations respectively.

2395. With reference to the 5th head, the reporter should also prepare himself for drawing it out by taking judicious notes in respect to the crop in any particular plantation, or in reference to that on any part of one which seems particularly good of the age, so as to illustrate facts in reference to his general recommendations for the improvement of the whole; and he should be careful to show the cause of such trees being so much better than others of the same age, &c.

2396. In reference to the 6th head, we need only remark that the reporter should be as careful to show the cause of disease in one crop, or part of one, as he is to show the cause of the opposite state, as the illustration of both heads is equally necessary for the guidance of the proprietor and his forester.

2397. Although all the headings set forth for description in the 2389th paragraph are absolutely necessary to make up a proper and useful report on woods, still it may be safely stated that the 7th subject is the most important, and should therefore be illustrated in the most minute, careful, and intelligible manner, as upon the proper laying down of suitable rules for the after-guidance of the forester in all the different branches of the work, the advantages derivable from such a report depends. This subject should therefore be carefully taken up and discussed, and a right system of forestry laid down for the guidance of the proprietor who employs him.

2398. We need make no comment on the subject of the 8th head, as it is short and clear of itself, and should be taken up and proper recommendations given according to the nature of the country.

2399. The 9th head is a very important one also, and should be carefully attended to by the reporter, especially in reference to depth and distance apart of the drains, according to the nature of the land. He should also note the probable expense of the drains to be made in each separate enclosure, and the extent necessary to have operated on in each case; and he should draw up a statement showing the particulars of all drainage operations he proposes for the improvement of the crop of each enclosure.

2400. A tabular statement should be drawn up in reference to the subject of the 10th head, showing the extent to be replanted in each separate plantation, the kinds of plants to be used, and the expense of the operation; and any explanation may be given by the reporter on the results brought out in such a statement, as may seem most necessary for the cases.

2401. The 11th head has reference to the planting of new enclosures; and as this is a most important point, every particular in regard to the proper performance of the work should be clearly and intelligibly laid down, so that no two opinions may arise on any point afterwards. After detailing as to fencing and draining, the reporter should show the parts, *by a plan*, on which to plant the several sorts of trees, and should state the distance apart of the young plants to be used, &c. &c.

2402. The 12th head has reference to the particular mode of pruning which should be adopted for the improvement of young hardwood trees: regarding this we may only state, that a judicious reporter, who understands his subject, will be very guarded as to how far he recommends this operation as an improvement in respect to young trees, as there is, generally speaking, more harm done by pruning than advantage gained by it: still the subject should be referred to.

2403. The 13th head is also a very important one, and should on that account be minutely gone into. The reporter should give a specimen of his mode of thinning in each plantation he recommends to be thus operated on, and to these specimens he should refer under this head. He should, at the same time, give specifications as to the general mode and expense of the operation in reference to the crop in each separate plantation, as well as any other particulars that occur to him on the subject.

2404. As the subject of the 14th head is, as it were, the harvest of all the operations, the greatest care should be taken to show the quantities of wood, bark, &c., that may be taken from each wood to be operated on, in a given year, and its value according to the present prices. A proper tabular statement should be drawn up, showing the probable amount of income from each of the woods to be operated on for the year, and his grounds for arriving at such conclusions in respect to this. He should, of course, carry his statement as to income over a given number of years, and afterwards the proprietor will be able to ascertain from after results how far the reporter formed a correct estimate.

2405. The 15th head is also an important one, and should be very correctly gone about in making calculations in regard to it. Every item of expense should be noted, under its own proper head: for particulars, see statement in next section, in reference to explanation.

2406. Heading 16th is a subject of very great importance to attend to in reporting on woodlands, and should therefore be judiciously gone into. This subject should be taken up at such a length, as to explain every particular necessary to show how the present prices of wood are affected by roads and distance from market, and how higher prices might be realised, by adopting certain improvements in sales and the mode of transit.

2407. The 17th head should be in the form of a tabular statement, setting forth the points referred to; and as the making up of such a statement requires great judgment and experience to do it correctly, none should attempt it who has not full confidence in his own experience, as errors in this respect will soon appear against the reporter.

SECTION III.—SYSTEM OF BOOK-KEEPING ADAPTED TO FOREST OPERATIONS.

2408. To be able to keep correct and satisfactory accounts of all transactions, whether in respect to income or expenditure, is a great recommendation to the person who professes to manage any business; and this holds good in regard to a person who manages woods, as well as in any other profession. A forester who is not able to keep correct account-books, in reference to all the transactions that may pass under his hands, is not fit to fill a situation of any importance, and, in fact, must be considered as a mere woodman or wood labourer.

2409. We are aware that there are comparatively few foresters who are good accountants, and who can show to their employers, at any time they may wish it, the real state of income or expenditure in any given branch of the charge under them. Knowing, therefore, that foresters would be much benefited by having a system of book-keeping specially adapted to their use, and such a system as may be considered simple and comprehensive, we propose, in what follows of this section, to draw up such a system specially for their use, which we think will be found so simple as to be easily understood by any one of ordinary intelligence.

2410. The very first account which a forester should make out on entering on the duties of a new year (at whatever time of the year this may be—and this, of course, will always depend on the time that the proprietor makes up his yearly accounts), is an ESTIMATE setting forth the particulars of income and expenditure for the year to follow. Without such an estimate to guide both the forester himself and his employer, both would be, in regard to the works generally, similarly circumstanced to a mariner at sea without a chart. Such a statement is, in short, the groundwork of good management to a forester, in all his operations for the year afterwards, as well as highly satisfactory to the proprietor, inasmuch as it enables him to understand, at the commencement of the year, what the forester intends to draw for him as income from his woods, as well as what he intends to expend on the various works proposed to be performed. The following statement will make this clear at once. After giving it, we shall make some remarks in explanation.

2411. ESTIMATE of the probable INCOME from, and EXPENDITURE on, the WOODS and PLANTATIONS on the ESTATE of LYNMORE, for the year from 30th April 1880 to 1st May 1881.

		Amount.	Total.	Remarks.
INCOME FROM SALES BY PUBLIC AUCTION.				
From sales of 10,000 larch-trees on the Hill of Bands, say at 10s. per tree,		£5000 0 0		This valuation is taken on the ground of the larch bringing 1s. per foot; Scots pine at 8d. per foot.
From sales of 12,000 Scots pine trees, in Plantation of Gorry, at 6s. per tree,		3600 0 0		
From sales of oak timber from Adam's Wood, say 5000 feet at 2s. 6d. per foot,		625 0 0		
			£9225 0 0	
INCOME FROM SALES BY PRIVATE CONTRACT.				
From sales of pine and larch thinnings from the Plantations of Burnside, Woodhead, Clury, Laggan, and Lait,		700 0 0		
From thinnings of oak from Rettie, Sluggan, and Eden Plantations, . .		400 0 0		
From thinnings of mixed hardwoods, from Damhead and Strawn Plantations, .		200 0 0		
From 50 tons of bark, from old oak timber, say at £5 per ton, . . .		250 0 0		
From bark from thinnings of young oak plantations, say 80 tons, at £7 per ton,		560 0 0		
			£2110 0 0	
INCOME FROM NURSERY STOCK TO GO OUT NEXT AUTUMN AND SPRING.				
40,000 oak, at 30s. per 1000,	£60 0 0			
16,000 ash, at 25s. „	20 0 0			
4,000 elm, at 25s. „	5 0 0			
200,000 larch, at 10s. „	100 0 0			
400,000 Scots pine, at 6s. „	120 0 0			
6,000 spruce fir, at 12s. „	3 12 0			
		308 12 0		
666,000				
10,000 thorns, at 15s. per 1000, . .		7 10 0	316 2 0	
From Rents of three Lodges, ...		18 0 0	18 0 0	
From Rents of three Saw-mills, ...		110 0 0	110 0 0	
Total probable income for the year, ...			£11,779 2 0	

EXPENDITURE.	Amount.	Total.	Remarks.
Salaries and Allowances:			
Forester, ...	£300 0 0		
Horse-keep, ...	30 0 0		
Assistant, ...	100 0 0		
Horse-keep, ...	30 0 0		
Woodmen in charge of enclosures, four at £40 each, ...	160 0 0		
Clerk to Forester, ...	60 0 0		
		£680 0 0	
Fencing:			
Braidwood Hill to enclose for planting, say 3500 yards of wire fence, at 8d. per yard, ...	116 13 4		
Thortown Bridge to enclose for planting, say 4000 yards of stone wall, 5 feet high, at 2s. per yard, ...	400 0 0		
General repair of fences on enclosures, .	150 0 0		
Repairs of gates on enclosures, ...	20 0 0		
		686 13 4	
Draining:			
Braidwood Hill, 30 acres of, say at £3 per acre, ...	90 0 0		
Thortown Bridge, 45 acres of, say at £3, 5s. per acre, ...	146 5 0		
		236 5 0	
Planting:			
Braidwood Hill and Thortown Bridge enclosures, 666,000 plants, as per statement under heading of income, *Nursery Stock to go out*, ...	308 12 0		
Expense of planting, ...	99 18 0		
60,000 pits for hardwoods, at 1s. per 100, .	30 0 0		
Carriage of plants, ...	10 0 0		
		448 10 0	
Lodges:			
Repairs of, ...	70 0 0		
		70 0 0	
Water-Runs:			
Repairs of sides of, ...	110 0 0		
		110 0 0	
Saw-mill Dams:			
Repairs of, ...	30 0 0		
		30 0 0	
Roads, Rides, and Walks:			
New road from Saltown Bridge to Westergates, say 2300 yards, at 1s. 6d. per yard,	172 10 0		
Repairs of roads generally, . . .	30 0 0		
Repairs of rides, ...	18 0 0		
Repairs of walks, and cleaning, . .	40 0 0		
		260 10 0	
Carry forward, . .		£2521 18 4	

	Amount.	Total.	Remarks.
Brought forward, . .		£2521 18 4	
Hedging:			
On side of proposed new road betwixt Saltown Bridge and Westergates, preparing 1666 yards of bed for thorn plants, at 6d. per yard, ...	41 13 0		
10,000 plants, at 15s. per 1000, . .	7 10 0		
Planting, ...	2 10 0		
Carriage of plants, ...	0 5 0		
Cleaning of hedges generally, . . .	60 0 0		
Switching of hedges „ . . .	50 0 0		
		161 18 0	
Felling and Preparing Oak Timber for Sale:*			* In Adam's Wood.
Say 100 trees, at 2s. 6d. per tree, . .	£12 10 0		
		12 10 0	
Stripping and Curing Oak Bark:			
Say 130 tons, at £2, 10s. per ton, . .	325 0 0		
		325 0 0	
Thinning:			
Pine and larch plantations, as named in estimate of income, ...	235 0 0		
Oak and mixed hardwood plantations, as named in estimate of income, . .	60 0 0		
		295 0 0	
Clearing and Burning Rubbish:			
From cleared land, Heathfield enclosure, say	30 0 0		
		30 0 0	
Pruning:			
Young oak plantation at Rymore, say .	8 0 0		
		8 0 0	
Nursery:			
Plants required for next year's stock—			
20,000 oak, 1-yr. seedling, at 7s. 6d. per 1000,	7 10 0		
10,000 ash, 2-yr. do., at 7s. per 1000, .	3 10 0		
3,000 elm, 2-yr. do., at 7s. 6d. per 1000,	1 2 6		
150,000 larch, 1-yr. do., at £12 per 100,000,	18 0 0		
300,000 S. pine, 1-yr. do., at £17 per 100,000,	51 0 0		
2,000 silver fir, 2-yr. do., at 7s. 6d. per 1000,	0 15 0		
5,000 spruce fir, 2-yr. do., at 3s. per 1000,	0 15 0		
2,000 sycamore, 2-yr. do., at 10s. per 1000,	1 0 0		
500 lime-tree, at 15s. per 100, . .	3 15 0		
500 new coniferæ, of sorts, at 1s. each,	25 0 0		
8,000 thorns, at 15s. per 1000, . .	6 0 0		
501,000		118 7 6	
Nursery Labour:			
Laying 501,000 plants at 1s. per 1000, .	25 1 0		
Cleaning, ...	8 0 0		
Lifting, ...	6 0 0		
Digging, ...	7 0 0		
Manure, ...	5 0 0		
		51 1 0	
Carry forward, . .		£3523 14 10	

	Amount.	Total.	Remarks.
Brought forward,	. .	£3523 14 10	
Travelling expenses of forester and assistant,	25 0 0		
Stationery,	8 0 0		
Criminal prosecutions,	35 0 0		
Carpenter work,	4 0 0		
Smithy work,	10 0 0		
Ironmongery,	8 0 0		
Keep of forest work-horse,	25 0 0		
Wages of carter,	30 0 0		
Repairs of harness (or saddlery),	3 0 0		
Advertisements of timber sales,	15 0 0		
Sale dinners,	10 0 0		
Printing catalogues and bills,	5 0 0		
Auctioneer charges,	10 0 0		
Rates and taxes,	80 0 0		
		268 0 0	
Total probable expenditure for the year,	. .	£3791 14 10	

ABSTRACT.

Estimated income,	£11,779 2 0
Estimated expenditure,	3,791 14 10
Estimated net income,	£7,987 7 2

2412. The foregoing statement is an example of the way in which we, at the beginning of every year, make up an estimate of the income expected to be derived from the produce of such forests and plantations as we have to do with, and the expenditure to be laid out on them, a copy of which we register in a book kept specially for the purpose, and another we give to our employer, who, of course, has it in his power to object to any particular work proposed, or to approve of the whole, as may seem most desirable; and after being investigated and sanctioned by him, the works detailed pass into law for the season, and are afterwards set about by degrees, according to the season and nature of the work,—it being always understood that the several works set forth are to be finished before the end of the year.

2413. Although the statement we have given embraces somewhat extensive sales of produce, as well as large works to be performed, still the model is equally applicable to estimates of all dimensions, whether in regard to estates on which there are only 300 acres of woods, or from 20,000 to 100,000 acres, or more; all the difference being, that the sums will be large or small according to the extent of woods to be operated on.

2414. In drawing up such a statement, however, the forester should be most careful in making up his estimates, both in regard to the income and expenditure; for if they be not correct, the proof will undoubtedly tell against him at the end of the year, and from this his employer will at once learn whether he is qualified for his business, or the contrary.

2415. To avoid such an unpleasant state of things as has been hinted at above, in reference to incorrectness and incompetency in the forester, he should take ample time to calculate the value of the produce he intends to remove from any and every plantation he proposes to operate on for the year, and also that of the different works he sees necessary to have done. In short, in making up his statement, he should enter in it every item of income or expense he anticipates for the year; and this may be £100 or £20,000, according to the character of the establishment.

2416. On the supposition, then, that such an estimate has been formed for the year, the next step in the system of book-keeping which we propose to lay before the reader is the keeping of the Day-Labour Book. This is simply a detailed statement, in a tabular form, of what the workmen are employed at each day, with some other particulars, as will be clearly understood from the following specimen-sheets from our own book, kept for the like purpose, and which embrace the particulars of the labourers' work for one month.

2417. STATEMENT of Workpeople employed in the Woods and Plan-

DAYS OF THE WEEK.	MONDAY.	Days.	Hours.	TUESDAY.	Days.	Hours.	WEDNESDAY.	Days.	Hours.
DAYS OF THE MONTH.	30.			1st May.			2.		
STATE OF THE WEATHER.									
THERMOMETER.									
A. M'Gregor,	Felling Oak Timber, Adam's Wood.	1	0	Felling Oak Timber, Adam's Wood.	1	0	Felling Oak Timber, Adam's Wood.	1	0
J. Grant, .	... ...	1	0	... ...	1	0	... ...	1	0
D. Fraser, .	... ...	1	0	... ...	1	0	... ...	1	0
J. M'Donald,	... ...	1	0	... ...	1	0	... ...	1	0
W. Scott, .	... ...	0	5	... ...	1	0	... ...	1	0
D. Ross, . .	... ...	0	5	Absent.	0	0	... ...	1	0
W. Calder, .	... ...	0	5	... ...	0	0	... ...	1	0
A. Robertson,	... ...	0	5	Felling Oak Timber,	1	0	... ...	1	0
J. Watson, .	... ...	1	0	... ...	1	0	... ...	1	0
J. M'Cook, .	... ...	1	0	... ...	1	0	... ...	0	5
H. Cameron,	... ...	0	5	... ...	1	0	... ...	1	0
DAYS OF THE MONTH.	7.			8.			9.		
STATE OF THE WEATHER.									
THERMOMETER.									
A. M'Gregor,	Thinning Bankhead Oak Plantation.	1	0	Thinning Bankhead Oak Plantation.	1	0	Cleaning Hedges, North Park.	1	0
J. Grant, . .	... ...	1	0	... ...	1	0	... ...	1	0
J. M'Donald,	... ...	1	0	Absent.	0	0	... ...	1	0
W. Scott, .	... ...	1	0	Thinning Bankhead Oak Plantation.	1	0	... ...	1	0
A. Robertson,	... ...	1	0	... ...	1	0	... ...	1	0
D. Ross, . .	... ...	1	0	... ...	1	0	... ...	1	0
W. Calder, .	... ...	1	0	... ...	1	0	... ...	1	0
J. Watson, .	... ...	1	0	... ...	1	0	... ...	1	0
H. Cameron,	... ...	1	0	... ...	1	0	... ...	1	0
J. M'Cook, .	... ...	1	0	... ...	1	0	... ...	1	0
D. Fraser, .	... ...	1	0	... ...	1	0	... ...	1	0
T. Low, . .	Absent.	0	0	Absent.	0	0	... ...	1	0

tations on the Estate of Lynmore, from 30th April to 12th May 1880.

THURSDAY.	Days.	Hours.	FRIDAY.	Days.	Hours.	SATURDAY.	Days.	Hours.	Total No. of Days.	Rate per Day.	Amount.
3.			4.			5.					
										s. d.	£ s. d.
Felling Oak Timber, Adam's Wood.	1	0	Felling Oak Timber, Adam's Wood.	0	5	Thinning Bankhead Oak Plantation.	1	0	5.5	2 6	0 13 9
... ...	1	0	... ...	0	5	... ...	1	0	5.5	2 0	0 11 0
... ...	1	0	Absent.	0	0	... ...	1	0	5.0	...	0 10 0
... ...	1	0	... ...	0	0	... ...	1	0	5.0	...	0 10 0
... ...	1	0	... ...	0	0	... ...	1	0	4.5	...	0 9 0
... ...	1	0	... ...	0	0	... ...	1	0	3.5	...	0 7 0
... ...	1	0	... ...	0	0	... ...	1	0	3.5	...	0 7 0
... ...	1	0	... ...	0	0	... ...	1	0	4.5	...	0 9 0
... ...	1	0	... ...	0	0	... ...	1	0	5.0	...	0 10 0
... ...	1	0	... ...	0	0	... ...	1	0	4.5	...	0 9 0
... ...	0	5	... ...	0	0	... ...	1	0	4.0	...	0 8 0
											5 3 9
10.			11.			12.					
Repairing Fences, on South District of Enclosures.	1	0	Repairing Fences on South District of Enclosures.	1	0	South District Enclosure, Scouring Drains.	1	0	6.0	2 6	0 15 0
... ...	1	0	... ...	1	0	... ...	0	5	5.5	2 0	0 11 0
... ...	1	0	... ...	1	0	... ...	0	5	4.5	...	0 9 0
... ...	1	0	... ...	0	5	... ...	1	0	5.5	...	0 11 0
... ...	1	0	... ...	1	0	... ...	1	0	6.0	...	0 12 0
... ...	0	5	... ...	1	0	... ...	1	0	5.5	...	0 11 0
... ...	1	0	... ...	1	0	Absent.	0	0	5.0	...	0 10 0
... ...	0	5	... ...	1	0	... ...	0	0	4.5	...	0 9 0
... ...	0	5	... ...	1	0	... ...	0	0	4.5	...	0 9 0
... ...	1	0	... ...	1	0	Scouring Drains.	1	0	6.0	...	0 12 0
... ...	1	0	... ...	1	0	.. ...	1	0	6.0	...	0 12 0
... ...	1	0	... ...	1	0	... ...	1	0	4.0	...	0 8 0
											6 9 0

STATEMENT of Workpeople employed in the Woods and Plan-

DAYS OF THE WEEK.	MONDAY.	Days.	Hours.	TUESDAY.	Days.	Hours.	WEDNESDAY.	Days.	Hours.
DAYS OF THE MONTH.	14.			15.			16.		
STATE OF THE WEATHER.	Dry with high wind.			Cloudy but dry.			Partly cloudy and partly sunshine.		
THERMOMETER AT NINE A.M.	54°			48°			51°		
A. M'Gregor,	Thinning Sluggan Plantation.	1	0	Home Policy, Cleaning Walks,	1	0	Home Policy, Cleaning Walks.	1	0
J. Grant, . .	... ...	1	0	... ...	1	0	... ...	1	0
D. Ross, . .	... ...	0	5	... ...	1	0	... ...	1	0
W. Scott, .	... ...	1	0	... ...	1	0	... ...	1	0
D. Fraser, .	Absent.	0	0	... ...	1	0	... ...	1	0
J. M'Donald,	... ...	0	0	... ...	1	0	... ...	1	0
W. Calder, .	Thinning Sluggan Plantation.	1	0	... ...	1	0	... ...	1	0
J. Watson, .	... ...	1	0	... ...	1	0	... ...	1	0
A. Robertson,	... ...	1	0	... ...	0	5	... ...	1	0
J. M'Cook, .	... ...	1	0	... ...	1	0	... ...	1	0
H. Cameron,	... ...	0	5	... ...	1	0	... ...	1	0
T. Low, . .	... ...	1	0	... ...	1	0	... ...	1	0
DAYS OF THE MONTH.	21.			22.			23.		
STATE OF THE WEATHER.									
THERMOMETER.									
A. M'Gregor,	Thinning in Eden Plantation.	1	0	Thinning in Eden Plantation.	1	0	Thinning in Eden Plantation.	1	0
J. Grant, . .	... ...	1	0	... ...	1	0	... ...	1	0
D. Ross, . .	... ...	1	0	... ...	1	0	... ...	1	0
W. Scott, .	... ...	1	0	... ...	1	0	... ...	0	5
D. Fraser, .	... ...	1	0	... ...	1	0	... ...	0	5
T. Low, . .	... ...	1	0	... ...	1	0	... ...	0	5
J. M'Cook, .	... ...	1	0	... ...	1	0	... ...	1	0
H. Cameron,	... ...	1	0	... ...	1	0	... ...	1	0
A. Robertson,	... ...	1	0	... ...	1	0	... ...	1	0
J. Watson, .	... ...	1	0	... ...	1	0	... ...	1	0
W. Calder, .	... ...	1	0	... ...	0	5	... ...	0	5
J. M'Donald,	... ...	1	0	... ...	1	0	... ...	1	0

tations on the Estate of Lynmore, from 14th to 26th May 1880.

THURSDAY.	Days.	Hours.	FRIDAY.	Days.	Hours.	SATURDAY.	Days.	Hours.	Total No. of Days.	Rate per Day.	Amount.
17.			18.			19.					
Clear sunshine.			Cloudy.			Showery.					
54°			45°			48°					
										s. d.	£ s. d.
Pruning Oaks in Rymore Plantation.	1	0	Pruning Oaks in Rymore Plantation.	1	0	Pruning Oaks in Rymore Plantation.	0	5	5.5	2 6	0 13 9
... ...	1	0	... ...	1	0	Absent.	0	5	5.5	2 0	0 11 0
... ...	1	0	... ...	1	0	... ...	0	0	4.5	...	0 9 0
... ...	1	0	... ...	1	0	... ...	0	0	5.0	...	0 10 0
... ...	1	0	... ...	1	0	... ...	0	0	4.0	...	0 8 0
Absent.	0	0	... ...	1	0	... ...	0	0	3.0	...	0 6 0
... ...	0	0	... ...	1	0	... ...	0	0	4.0	..	0 8 0
Pruning Oaks in Rymore Plantation.	1	0	... ...	1	0	... ...	0	0	5.0	...	0 10 0
... ...	1	0	... ...	1	0	... ...	0	0	4.5	...	0 9 0
... ...	1	0	... ...	1	0	... ...	0	0	5.0	...	0 10 0
... ...	1	0	... ...	1	0	... ...	0	0	4.5	...	0 9 0
... ...	1	0	... ...	1	0	... ...	0	0	5.0	...	0 10 0
											5 13 9
24.			25.			26.					
Cleaning Nursery.	1	0	Lotting Oak Timber for Sale, Adam's Wood.	1	0	Lotting Oak Timber for Sale, Adam's Wood.	1	0	6.0	2 6	0 15 0
... ...	1	0	... ...	1	0	... ...	1	0	6.0	2 0	0 12 0
... ...	1	0	... ...	1	0	... ...	1	0	6.0	...	0 12 0
... ...	1	0	... ...	1	0	... ...	1	0	5.5	...	0 11 0
... ...	1	0	Absent.	0	0	... ...	1	0	4.5	...	0 9 0
... ...	1	0	... ...	0	0	... ...	1	0	4.5	...	0 9 0
... ...	1	0	... ...	0	0	... ...	1	0	5.0	...	0 10 0
... ...	1	0	... ...	0	0	... ...	1	0	5.0	...	0 10 0
... ...	1	0	Lotting Oak Timber, Adam's Wood.	1	0	... ...	1	0	6.0	...	0 12 0
... ...	1	0	... ...	1	0	Absent.	0	0	5.0	...	0 10 0
... ...	1	0	... ...	1	0	... ...	0	0	4.0	...	0 8 0
... ...	1	0	... ...	1	0	... ...	0	0	5.0	...	0 10 0
											6 8 0

STATEMENT *of Day Labour for the Month.*

First week, ...	5 3 9
Second week, ...	6 9 0
Third week, ...	5 13 9
Fourth week, ...	6 8 0
	23 14 6

2418. The foregoing system of keeping the particulars in regard to the labourers' time is so very clear and simple, that little or no explanation seems necessary on it. Still, for the benefit of young and inexperienced men in the profession, we shall advert a little to it, and give such explanation as we think most likely to be useful.

2419. It will be observed from the heading of this copy of day-labour book, that the month begins on Monday the 30th April, which is supposed to be the first month of the business or financial year on the estate of Lynmore; but it must be clearly understood that no precise month need be taken as the beginning of the year in making out such a statement, as this may be any month, according to the usual business year maintained on the property, in respect to the winding-up of financial affairs.

2420. Under the heading, the two pages are divided, from bottom to top, into seven great columns—apart from the money columns, &c.—the first on the left-hand side for the names of the men employed, and the other six for the working days of the week; with intermediate small columns for the days and hours that each man is employed. After the days of the week, there is a column for the total number of days each man is employed during the week; next comes a column for the rate of wages he receives per day; and lastly comes one in the usual manner of money columns, in which the sum each man is to receive in that week is entered.

2421. If there are not many men employed, one opening of the book, or two opposite pages, will hold the transactions of two weeks; but if many are employed, it will take all the space of the two pages to do justice to the description of the work; and of course this must always be regulated according to the nature of the establishment. In giving the foregoing copy of our day-labour book, we have preferred to give it exhibiting two weeks' labour on the opening of the book, with the view of showing how this is done when necessary,—which is merely to draw the lines across the middle of the pages, as at the top of the pages.

2422. We have described the use of the columns divided by the upright lines on the pages. With regard to the horizontal lines, which intersect the others from side to side of the page, the first from the top is to make a column for the days of the week, which are stated each in its compartment, and at the head of its own special column. Immediately under this is another horizontal line from side to side, causing compartments at the tops of the several columns for the days of the month; and thus the days of the week and the days of the month are made to correspond to each other; next in order, and under the compartments for the days of the month, are those for the state of the weather, which should always be noted by the forester; and lastly, there is the line of compartments for the registry of the thermometer, which should also be regularly attended to, as shown in paragraph 2417.

2423. We shall carry our remarks a little further, and show how the men's time is registered in this book; and in order to this, we shall describe the entries made in reference to one or two of them. A. M'Gregor, the first man named on the list for the week ending on Saturday the 5th of May, is, under Monday the 30th April, stated as felling oak timber in Adam's Wood, and on the same day the other ten men were employed at the same work in the same wood. Of course, where the men are at different works, the work that each man is engaged in must be carefully described under the date, and in the compartment for the purpose. But we need not enlarge on this point, as the reading of the columns themselves are so clear that they can hardly be misunderstood.

2424. It will be observed that in the statement for the week ending Saturday the 12th May, the same man, A. M'Gregor, is registered on the 10th, and the following day, as repairing fences on the south district of enclosures, and that on the same days, all the other men were employed at the same work with him; but that on Saturday William Calder, James Watson, and H. Cameron, are marked absent, all the others being engaged in scouring drains in south district inclosures. All this, we think, is clear enough to be understood by any forester; still there are a few points yet to be remarked on the subject, which must be carefully noted.

2425. The particulars of each day's operations, so far as the labouring men are concerned, should be marked down in the evening, when the forester returns home, and should on no account be left till another day, when it is probable that new works will distract his mind, and prevent his noting so correctly the transactions of the previous day.

2426. The forester must always be careful, in keeping the day-labour book, not only to note the different operations that the different men may have been engaged in during each day, but also to note very particularly the district or particular plantation on which the work has been performed, as without this he could not fill up satisfactorily the next book to be described (the Pay-List), neither could he note correctly, at the end of the financial year, when the different operations had been performed, in what plantation, or in what part of the estate, the work had been done. This, therefore, should be kept specially in view by the forester. To the inexperienced book-keeper in forestry this may seem a matter of little consequence; but to the man who has had much experience in rendering correct accounts to his employer, it is found of vast importance, as will more particularly appear as we proceed with our proposed system.

2427. It is also necessary that the forester should, on the evening of each date, note in its proper place the general state of the weather, as well as the degree of the thermometer, at a given time of the day: we have noted it at 9 A.M. as a convenient time, but it ought to be taken at the height of the day also, and in the afternoon as well.

2428. Men employed in contract or piece work should not, of course, have their time noted in the book under notice, but only day-labourers, as the statement in respect to contract-work will be accounted for elsewhere.

2429. The day-labour book should be made so large as to last one year, so that reference can be made to each book for the labour of the year it represents.

The next book in the order of the system is the Pay-List of Day-Labour and Piece-work. The following is a sample of it:—

the Estate of Lynmore, for Month ending 26th May 1880.

Nos.		9. ...den. ...ning. Amount	10. Nursery. Cleaning. Days	10. Nursery. Cleaning. Amount	11. Adam's Wood. Lotting Timber. Days	11. Adam's Wood. Lotting Timber. Amount	12.	13. Total No. of Days.	14. Rate per Day.	15. Total Amount.	16. We, the undersigned, acknowledge to have received from —— —— the sums set opposite our names respectively, as payment of our wages for the time herein set forth.
		£ s. d.		£ s. d.		£ s. d.			s. d.	£ s. d.	
1.	A.	7 6	1	0 2 6	2	0 5 0		23.0	2 6	2 17 6	(Signed) A. M'Gregor.
2.	J.	6 0	1	0 2 0	2	0 4 0		22.½	2 0	2 5 0	,, J. Grant.
3.	D.	5 0	1	0 2 0	1	0 2 0		19.½	2 0	1 19 0	,, D. Fraser.
4.	J.	6 0	1	0 2 0	1	0 2 0		17.½	2 0	1 15 0	,, J. M'Donald.
5.	W.	5 0	1	0 2 0	2	0 4 0		20.5	2 0	2 1 0	,, W. Scott.
6.	D.	6 0	1	0 2 0	2	0 4 0		19.½	2 0	1 19 0	,, D. Ross.
7.	W.	4 0	1	0 2 0	1	0 2 0		16.½	2 0	1 13 0	,, W. Calder.
8.	A.	6 0	1	0 2 0	2	0 4 0		21.0	2 0	2 2 0	,, A. Robertson.
9.	J.	6 0	1	0 2 0	1	0 2 0		19.½	2 0	1 19 0	,, J. Watson.
10.	J.	6 0	1	0 2 0	1	0 2 0		20.½	2 0	2 1 0	,, J. M'Cook.
11.	H.	6 0	1	0 2 0	1	0 2 0		18.0	2 0	1 16 0	,, H. Cameron.
12.	T.	5 0	1	0 2 0	1	0 2 0		13.½	2 0	1 7 0	,, T. Low.
		8 6		1 4 6		1 15 0				23 14 6	

Total Amount of Day-Labour, 23 14 6

Nos.		Quantity.	Rate per Yard.	Amount paid for Piece-Work.		
			s. d.	£ s. d.		
13.		2000 yards	0 2	16 13 4		,, J. Smith.
14.		1000 ,,	0 8	33 6 8		,, A. Cameron.
15.		1200 ,,	2 0	120 0 0		,, J. M'Gregor.
		Amount for Piece-Work, .		170 0 0	170 0 0	

Total Amount, . . 193 14 6

2432. The specimen-sheet just given of the book called the Pay-List of Day-Labour and Piece-Work, contains the entire labour transactions of the month, or four weeks, as particularised in the specimen given of the Day-Labour Book itself, together with the contract or piece-work performed and paid for during the same period. The day-labour part of the sheet, embraced under paragraph 2430, contains, in a condensed form, all the different works every man has been employed at during the month, and as particularised in the day-labour book, while the piece-work part of it, embraced under paragraph 2431, contains also in a condensed form, but with all the particulars necessary for the proper description for payment, the contract-work that has been performed and falls to be accounted for, for the month.

2433. As an example, we shall take up the time of the man Alexander M'Gregor, who is first named on the list, and whose number is therefore 1. Under column No. 1 he is set down as having been 4 days and 5 hours employed in felling oak timber in Adam's Wood; under the 2d, as having been 3 days engaged in thinning Bankhead Plantation; under the 3d, 1 day employed cleaning hedges on North Park; under the 4th, 2 days in the repairing of fences on the enclosures of the South District,—and so on, with the days set down opposite to his name. On summing up the whole of this man's time, it will be found to be 23 days in all, which is the number set down for him to receive payment for under column 13, which contains the total number of days each man has been employed during the 4 weeks. Under column 14 it will next appear, in respect to this man, that his rate of wages is 2s. 6d. per day; consequently his 23 days at this rate amount to £2, 17s. 6d., which is set down in column 15; and on his receiving this pay, he acknowledges it by signing his name on a stamp, under the 16th column; and so on with all the other men whose names follow on the sheet, each man signing his name on a stamp when his amount is £2 and upwards. This, we think, is sufficient explanation on this point.

2434. By examining Alexander M'Gregor's time, as stated in the Day-Labour Book, it will be found that it exactly corresponds with the number of days set down for him in the pay-list, which, of course, ought to be the case in respect to all the men's names set down in these statements, as if the one statement do not correspond with the other in this respect, it is an indication that there is an error somewhere, which of course should be checked.

2435. The great advantage of this mode of keeping men's time is, that it forms a complete account of all that they are employed at, in the least possible space, and yet is as clear and to the point as if volumes were written in regard to it. It is a system entirely of our own invention, and is now used on many places, and found to answer the purpose admirably, and forms a complete receipt for all day-labourers' wages.

2436. The great advantage we find to result from this mode of keeping our pay-list for workmen is, its bringing out, at the end of each month, the exact expense that has been incurred on each branch of work. For example, we at once see that £4, 1s. 3d. has been expended under column No. 1, for felling oak timber in Adam's Wood; £3, 5s. 6d. under column No. 2, for thinning Bankhead Plantation; and so on, with the sums set down under each of the headings; and as each of the headings of the columns is filled up every month, as the different works require, these sheets, at the end of the year, form a complete history of the workmen's time, which is of vast importance in the keeping of correct accounts on all such matters, and in making up the actual amount of expenditure at the end of the year.

2437. It will be observed, at the end of paragraph 2417, that the statement of day-labour for the 4 weeks amounts to £23, 14s. 6d. in all, and that this corresponds with the sum brought out as the result of the expenditure in the pay-list at the end of paragraph 2430. This point should, of course, be particularly attended to, as, if an error occur, and the accounts do not correspond, it might lead to a great amount of labour at the end of the year.

2438. We have yet to make a few remarks in respect to that part of the pay-list which sets forth the contract or piece-work performed during the month, and which is entered under paragraph 2431, and on the same page or sheet with the day-labour. It is necessary and desirable that both should be entered on one sheet, in order to bring out the whole as one account at the end of the month.

2439. Before entering into any bargain with parties to perform such work, we have specifications drawn up on stamped paper, setting forth all particulars in regard to it, which specifications are of course signed by the contracting parties. This arranged, we have next a formal agreement drawn up, also on stamped paper, setting forth the general conditions of the bargain, one condition being always that we are to pay them for such part of the work as may be finished to our satisfaction at the end of each month, and that their signing our pay-list for any such portion as shall be paid for at the end of any month shall be held as a sufficient receipt for such sums as they may receive on the work progressively. This, then, explains our mode of going to work in such works as we contract for, apart from day-labour.

2440. From the statement on the pay-list as to the piece-work for the month, it appears that James Smith had opened 2000 yards of drains in Braidwood Hill enclosure, at 2d. per yard; that Angus Cameron had erected 1000 yards of wire fence on the same enclosure, at 8d. per yard; and that John M'Gregor had 1200 yards of stone wall on the enclosure of Thortown, at 2s. per yard,—the sums of all of which are set down and paid, and signed by the parties, each opposite to his account.

2441. From both branches of this statement, then, it is brought out that £23, 14s. 6d. was paid for day-labour during the month, and £170 for piece-work—or in all, £193, 14s. 6d., which the forester will set down in his cash-book accordingly.

2442. The cash-book is the next one in the order of the system, and this we keep by single entry, or single money columns. In this book every sum is entered as it is paid, for whatever purpose, taking care to have a receipt for the smallest sum paid, for whatever it may be. This is absolutely necessary in the case of the forester, as he must of course render a proper account of his employer's money. The following page will show our mode of keeping an account of all sums paid out:—

2443. John Woodford, in account with Lord E——d. *Cr.*

1880.				
May 8.	Paid Robert Manfred for scouring drains in Stockston Plantation, per contract, as per agreement and receipt,. .	£7	10	0
„ „	Paid James Strachan for one quarter of oats, for forest horse, as per account, ...	1	2	0
„ „	Paid Samuel Walker for paper, note-books for foremen, pens and ink, &c., for the forester's office, as per account, .	1	3	6
„ 15.	Paid as travelling expenses, two days in visiting southern district of plantations, ...	0	15	0
„ „	Paid Robert Dickson for axes, saws, and hammers for workmen on western district of plantations, as per account, .	4	8	6
„ 16.	Paid John Mathewson, carpenter, Newlands, for a new cart for forest work, as per account, ...	5	18	0
„ „	Paid Robert Welbeck for erecting a new tank in Bancroft Wood, in which to prepare timber for fencing purposes, as per account, with specification, ...	4	6	0
„ 23.	Paid as travelling expenses, three days in inspecting operations on the western district of plantations, . . .	1	2	6
„ 26.	Paid pay-list of day labour and piece-work, performed in the woods and plantations, for the month ended on the 26th instant, as per pay-list, ...	193	14	6
	Carry forward, ...	£220	0	0

2444. From the foregoing example of the mode of keeping the cash-book, it will appear a simple and easy matter to the forester thus to note down, as he pays any account, the particulars of it, on the exact date of the transaction; and this noting down of the sums the forester may have occasion to pay is so easily understood, that we think the example page, which is supposed to contain the transactions of 1 month or 4 weeks, is sufficient, without much explanatory comment.

2445. For the information of young men, however, who may not have had the opportunity of much school education on the subject of book-keeping, we shall make a few general remarks in explanation of the items set down as paid in the cash-book. The first of these is £7, 10s. for scouring drains in Stockston Plantation. Now, with reference to this, it is to be clearly understood that the forester, in making an agreement with a party for the performance of such work, should have a written statement drawn out setting forth the nature of the work, and how it is to be done, and that this agreement should be signed by the party contracting for it. This attended to, when the forester pays the contractor, he should take a proper receipt from him, and fold this up along with the agreement, both of which should be properly labelled on the back or outer fold, so as the more readily to distinguish them at a glance from other documents among which they may happen to be laid. They may both be labelled in the way shown under:—

AGREEMENT.

ROBERT MANFRED,
for Scouring Drains,
Stockston Plantation,
1*st May* 1880.

RECEIPT.

ROBERT MANFRED,
for Scouring Drains,
Stockston Plantation,
£7, 10s.
8*th May* 1880.

2446. Having settled in regard to the agreement for the scouring of the drains, and paid for the work, both the agreement and receipt should be, as already said, tied together, and laid past in a drawer, which should be kept exclusively for the purpose of holding such documents. The advantages of such a mode of arrangement will be felt by the forester when, at the end of the year, he comes to make up a full statement of his accounts.

2447. The same mode of dealing with the other accounts should be maintained throughout; and the forester should never omit, when he pays out money on his employer's business, to procure a proper receipt for it, and next to enter the sum in his cash-book on the exact day on which it was paid, and to label the receipt, or, it may be, account, and lay it past in due order in his drawer.

2448. With regard to the forester's own expenses, it is not necessary that he should show a receipt for every small sum he may have occasion to pay out while travelling on his employer's business.

It will generally be enough if he present an account of such expenditure at the end of a month, or at the end of a year, according as his books are settled; but, for correctness, he should never neglect to enter in his cash-book the sums for travelling as they are paid.

2449. With regard to the account entered in the cash-book for day-labour and piece-work, amounting to £193, 14s. 6d., it is of course understood that the receipts for the various items which go to make up this sum are shown in the pay-list itself, and therefore reference is made to this book in the cash-book, where the receipts of the parties are to be seen.

2450. In the same way, the forester will enter all sums he pays out during the year in the cash-book; and, at the end of the year, when the accounts are to be arranged for settlement, they will fall to be entered in another book, a copy of which will be given in its place.

2451. The foregoing copies of books are, we think, enough for all purposes, in reference to the keeping of an account of the expenditure. We shall next show copies of our mode of keeping books in reference to the income from woods. The first is what we call "The Private Sales Book," a copy-sheet of which is given on the next page.

2452. The example, or copy-sheet, of our mode of keeping an account of sales by private contract is given under paragraph 2455; and this embraces all sales of timber for which ready money is received. A book ruled in the way shown is, we think, the most suitable of any form for registering small sales as they occur from time to time, and for which the money is paid at once; as in such cases it is not necessary to show anything other than the simple nature of the transaction, without reference to anything future in regard to it.

2453. The column on the left-hand side of the form is, of course, for the entering of the dates when the different sales are made; the next column is for the names of the purchasers, and after it is a column for their residences. Next in succession is a column for the names of the different plantations from which the timber was sold, and following this is another for the description of wood. All this, we think, is clearly shown on the copy itself.

2454. As a matter of convenience for entering the different quantities of wood sold, we have five columns divided off respectively for selling quantities: 1, per ton; 2, per hundred trees; 3, per dozen trees; 4, per tree; and, 5, per foot. This arrangement makes the different matters of entry more simple than could otherwise be in a book of this kind, where brevity, combined with explicitness, is very desirable. We shall just describe a few of the entries given in this example.

2455. SALES OF TIMBER by Private Contract, in the Woods and Plantations on the Estate of Lynmore, during the month of May 1880.

Date.	Names of Purchasers.	Residence.	Plantations from which sold.	Description of Timber.	1. Tons.	2. Hundred Trees.	3. Dozen Trees.	4. Trees.	5. Feet.	Rate.	Amount.	Total.
1880.												
May 1,	J. Ross,	Laggan,	Sluggan,	Small Oaks,	...	7	...	...	...	£5 0 0	£35 0 0	
" 3,	J. Grant,	Eden,	Burnside,	Scots Pine Thinnings,	...	9	...	...	...	2 10 0	22 10 0	
" 4,	W. Urquhart,	Do.,	Do.,	Paling Rails,	...	...	145	...	...	0 3 0	21 15 0	
" 14,	J. Calder,	Damhead,	Eden,	Burnwood,	50	...	...	...	...	0 15 0	37 10 0	
" 17,	G. Wallace,	Burnside,	Strawn,	Birch, for Powder-Wood,	76	...	...	...	...	1 2 0	83 12 0	
" "	D. M'Donald,	Clury,	Clury,	Scots Pine,	...	...	...	40	...	0 7 6	15 0 0	
" 19,	J. Cumming,	Smiddy Boyne,	Adam's Wood,	Oak,	...	...	...	...	270	0 2 6	33 15 0	
" "	G. Ogilvie,	Tulloch,	Lait,	Larch,	...	...	...	...	590	0 1 0	29 10 0	
" 23,	W. Scott,	Broomhill,	Do.,	Spar Wood,	...	...	30	...	...	0 18 0	27 0 0	
" 24,	J. Dundas,	Craggan,	Damhead,	Firewood,	25	...	...	...	...	0 6 0	7 10 0	
" "	G. Stewart,	Slapp,	Do.,	Ash,	...	...	...	...	75	0 1 6	5 12 6	
" 25,	A. Cameron,	Do.,	Strawn,	Elm,	...	...	...	...	215	0 1 8	17 18 4	
" "	R. Ewan,	Clayfolds,	Do.,	Decayed Trees,	...	...	...	27	...	0 1 0	1 7 0	
												£337 19 10

2456. PAYMENTS FROM CREDIT ACCOUNTS IN LEDGER.

Date.	Names of Purchasers.	Residence.		Amount.	Total.
" 17,	J. Gordon,	Miltown,	By Cash per Credit Account in Ledger, folio 1, ...	£150 0 0	
" 23,	A. M'Gregor,	Craigbea,	Do. do. do., folio 2, ...	68 0 0	
" 26,	W. Nisbet,	Woodhead,	Do. do. do., folio 3, ...	120 0 0	
					338 0 0
					£675 19 10

2457. The first entry made is in the name of John Ross, residing at Laggan, who, it appears, on the 1st of May, purchased from the plantation of Sluggan small oaks to the number of 700 trees, at £5 per 100, amounting to £35 in all. Passing the purchase made by James Grant on the 3d of May, we shall refer to that made by William Urquhart of Eden on the 4th. From the account, it is set forth that, on that date, he had purchased from the plantation of Burnside paling rails to the amount of 145 dozens of trees, at 3s. per dozen, and that the amount of his purchase is £21, 15s. We shall only refer to another sale—namely, that on the 14th, to James Calder of Damhead, who, it seems, bought from the plantation of Eden firewood to the extent of 50 tons. This, it will appear, had been sold to him at 15s. per ton, and that he had paid for it on the same date he made his purchase the price named—viz., £37, 10s. in all.

2458. In entering such sales, they can be carried forward from page to page, to any desired extent. We have only shown a few, simply to illustrate our mode of keeping an account of such transactions. This may be one week's or one month's transactions; but we have supposed it to be one month's.

2459. One great advantage resulting from this mode of keeping an account of wood sales is its simplicity and its correctness; and, not the least, its pointing out at a glance from what plantation each sale was made. The latter is a very great advantage when correct accounts of the produce from each plantation is an object, and it ought always to be one in every well-regulated establishment, as without such information the management of woods can never be clearly defined as to income and expenditure. In short, it is, in our opinion, of the greatest importance to be able to ascertain, at any time, what value of produce has been taken from a given plantation, as without this no proprietor can say whether such and such a plantation has paid him better than such another, or whether it has paid him at all.

2460. In paragraph 2456 of the same copy is also shown an account of payments made during the month by purchasers who had bought timber on credit—that is, this class of purchasers had bought produce from the woods on the understanding that they were to have a certain time allowed them to make payment, and that they were to do so as they found it convenient, within a reasonable time. Sales of this description are entered into another book, kept specially for the purpose, which is called the "Ledger." Before describing the nature of the entries made under paragraph 2456, we shall give a copy of the mode of keeping the account of such credit sales in the ledger. A copy of this book follows:—

2461. *Dr.* JOHN GORDON, Wood-merchant, Miltown.

1880.	Plantation from which sold.	Description of Timber.	Tons.	Hundred Trees.	Dozen Trees.	Trees.	Feet.	Rate.	Amount.	Total.
									£ s. d.	
May 4,	Clury,	Scots Pine,	...	...	...	370	...	at 9/	166 10 0	
" "	Lait,	Larch,	...	...	...	280	...	at 15/	210 0 0	
" 17,	Clury,	Scots Pine,	...	...	...	...	1160	at /9	43 10 0	

2462. *Dr.* ALEXANDER M'GREGOR, Wood-merchant, Craigbea.

1880.	Plantation from which sold.	Description of Timber.	Tons.	Hundred Trees	Dozen Trees.	Trees.	Feet.	Rate.	Amount.	Total.
									£ s. d.	
May 1,	Burnside,	Scots Pine Propwood,	...	...	290	...	...	at 4/	58 0 0	
" 3,	Lait,	Larch Propwood,	...	...	340	...	...	at 6/	102 0 0	

2463. *Dr.* WILLIAM NISBET, Saw-miller, Woodhead.

1880.	Plantation from which sold.	Description of Timber.	Tons.	Hundred Trees.	Dozen Trees.	Trees.	Feet.	Rate.	Amount.	Total.
									£ s. d.	
May 14,	Clury,	Scots Pine,	...	...	...	235	...	at 8/	94 0 0	
" 19,	Damhead,	Small Ash,	...	...	50	...	...	at 15/	37 10 0	
" "	Strawn,	Small Sycamore,	...	...	30	...	...	at 10/	15 0 0	

2464. *Dr.* JOHN MAXWELL, Wood-merchant, Burnside.

1880.	Plantation from which sold.	Description of Timber.	Tons.	Hundred Trees.	Dozen Trees.	Trees.	Feet.	Rate.	Amount.	Total.
									£ s. d.	
May 17,	Adam's Wood,	Oak Timber,	...	...	...	...	1200	at 2/3	135 0 0	
" 23,	Do.,	Oak Burnwood,	110	...	...	...	...	at 12/	66 0 0	
" 26,	Clury,	Oak Spokewood,	...	...	...	500	...	at 1/6	37 10 0	

2465. *Dr.* PETER GRANT, Wood-merchant, Ballintua.

1880.	Plantation from which sold.	Description of Timber.	Tons.	Hundred Trees.	Dozen Trees.	Trees.	Feet.	Rate.	Amount.	Total.
									£ s. d.	
May 1,	Clury,	Scots Pine,	...	...	...	700	...	at 8/	280 0 0	
" 14,	Do.,	Do.,	...	...	...	...	1300	at /9	48 15 0	
" 26,	Do.,	Scots Pine Paling Wood,	...	...	70	...	...	at 8/	28 0 0	

CONTRA. *Cr.*

1880.	Mode of Payment.	Discount.	Sums Paid.
May 17,	By Cash to Account, ...	... ...	£ s. d. 150 0 0

CONTRA. *Cr.*

1880.	Mode of Payment.	Discount.	Sums Paid.
May 23,	By Cash to Account, ...	... ...	£ s. d. 68 0 0

CONTRA. *Cr.*

1880.	Mode of Payment.	Discount.	Sums Paid.
May 26,	By Cash to Account, ...	... ...	£ s. d. 120 0 0

CONTRA. *Cr.*

1880.	Mode of Payment.	Discount.	Sums Paid.

CONTRA. *Cr.*

1880.	Mode of Payment.	Discount.	Sums Paid.

2466. From the examples shown in regard to the ledger, it is set forth that five different persons have opened accounts with the forester in the month of May, for purchases of timber made by them respectively on credit—viz., John Gordon, at paragraph 2461; Alexander M'Gregor, at paragraph 2462; William Nisbet, at paragraph 2463; John Maxwell, at paragraph 2464; and Peter Grant, at paragraph 2465.

2467. From paragraph 2461 it appears that John Gordon, on the 4th of May, purchased from the Clury Plantation 370 trees, at 9s. each, amounting to £166, 10s.; that, at the same time, he purchased also, from the Lait Plantation, 280 larch trees, at 15s. each, amounting to £210; and that on the 17th he purchased again, from the Clury Wood, 1160 feet Scots pine, at 9d. per foot, amounting to £43, 10s. These entries of sale, it is to be observed, are all entered on the left-hand, or debtor, page of the book, and regularly according to their dates. On the contra, or right-hand, page of the book, however, it will be observed that this John Gordon, on the day that he made his last purchase in Clury Plantation—on the 17th—had paid to the forester £150. This sum, then, is entered on the right-hand page under date the 17th May, and on this side all sums are entered as they are paid.

2468. The nature of this book, then, called the Ledger, is simply that the sales made are entered on the left-hand page of the book, and the payments, as they are made, are entered on the opposite page, when, at any time, it can be seen at a glance what sums are due and what paid; and of course when the sums on both sides are equal, the account is said to be balanced or settled.

2469. In the same way as has been described under paragraphs 2467 and 2468, all the accounts in the following pages of the copy of the ledger are entered and dealt with; and in a book of this kind there may be any number of purchasers entered for transactions, according to the extent of the sales made, on the principle of credit accounts, observing to give each purchaser a double page for his account. In making such sales, however, the forester requires to be very careful as to whom he deals with, as if they do not happen to be good men, from having no hold upon them beyond the timber lying in the plantations, he might incur heavy losses to his employer: this, therefore, ought to be kept specially in view in carrying on such transactions.

2470. We shall now refer to the account given under paragraph 2456, which we could not well have attended to till now, and which is set down under the private sales as payments on credit accounts in ledger. In looking over this statement, then, it appears, first, that on the 17th of May John Gordon of Miltown had paid cash, as per credit account in ledger, folio (leaf or page) 1, £150. Now, by taking up the copy given of the ledger, and examining John Gordon's account, given at page 1 of the ledger, this will be seen to correspond with the transaction as it took place, for at page 1 of the ledger, £150 is entered, on the right-hand side of the page, to the credit of John Gordon. Next, from the statement under paragraph 2456, it appears that Alexander M'Gregor had paid, on the 23d of May, cash to the amount of £68, and for the particulars of the transaction, the statement refers to the ledger at page or folio 2. Looking up for this in the ledger, then, at page 2, it is seen that this exactly corresponds with the transaction, for £68 is entered to the credit of A. M'Gregor in the account opened up with him at page 2. Again, it next appears that on the 26th May W. Nisbet had made a payment of £120; this is referred to the 3d page of the ledger, where the transactions in reference to this person are fully particularised on the left-hand page, and on the right it is shown that on the 26th of May he paid in the sum stated, and this he is given credit for in the usual way.

2471. The payments made from these three men are all set down under paragraph 2456, and amount in all to £338, which is set down in the columns for the total receipts of the month, and under the totals received from the ready-money sales; and thus it is brought out that the amount received for timber, by sales by private contract, during the month of May, is in all £675, 19s. 10d., all the particulars in regard to which sales are seen in the ready-money transactions under paragraph 2455, and in the ledger where the credit sales are particularised at the pages of this book referred to under paragraph 2456.

2472. This is all so plain that we think little further comment is required on the subject. We must remark, however, that the parties whose transactions are particularised under paragraphs 2464 and 2465 of the ledger, or on the 4th and 5th pages of that book, are represented as having made no payments in the month of May. This of course is known by no sums being entered to their credit on the right-hand pages of their accounts; so that all the timber they have bought is supposed to be still due.

2473. We now come to take up the subject of registering the transactions of sales of timber by public auction, which, generally speaking, are more complicated than those by private contract, inasmuch as the transactions are generally more extensive than private ones are, and also as they are to be guided by a class of rules understood to be previously laid down to be attended to by the seller on the one part and by the buyer on the other.

2474. For the sake of illustrating how public sales of timber should be registered in a book, we shall suppose that we have to dispose of the larch and pine trees referred to in the statement given in regard to the estimate of the probable income under paragraph 2411. By referring to that paragraph, it will be observed that we proposed there should be sold, from the Hill of Bands, by public auction, 10,000 larch trees, and we supposed that they would amount in value to 10s. each, or £5000 in all. We also proposed that there should be 12,000 Scots pine trees sold from the plantation of Gorry, and that they should bring 6s. each, or £3600 in all. The oak timber referred to in the paragraph under notice we shall take no account of at present, as it is to be understood that it cannot be had stripped and in readiness for sale so early as the month of May, when that sale of pine and larch is supposed to take place.

2475. Preparatory to this sale, then, the quantity of trees stated should be properly divided into lots, of various numbers, to suit the views of small and large purchasers, and to induce competition, so as to realise the highest possible price for each lot, and for the whole.

2476. We shall now suppose that this has been done, and that the 10,000 larch trees to be sold have been properly marked and arranged for sale; and that they are subdivided into 10 different lots, varying from 250 to 3000 trees; and that the 12,000 Scots pines have been dealt with in a similar manner, and subdivided into 17 different lots, varying from 250 to 2000 trees each; making in all 27 lots to be disposed of. These arrangements all made, and the timber sold, say on the 4th day of May, we should enter the different lots, and the whole of the money transactions in regard to them, in a book for the purpose, as shown in the next page, and which is in every respect a copy of the way we keep our own books for the registering of similar transactions.

—Account, Sales of Timber by Public Auction on the Estate of Lynmore, in 1880.

1. District or Plantation in which Sold.	2. Date of Sale.	3. No. of Lot.	4. Description of Timber.	5. Quantity.	6. Name of Purchaser.	7. Residence.	8. Rate.	9. Value.	10. Total Amount.	11. Discount.	12. Date of Payment.	13. Cash Received.			14. Sums Due.			15. Date of Full Payment.	16 Full Payment.	17. Remarks.
				Trees.				£	£		1880.	£	s.	d.	£	s.	d.			
Hill of Bands,	May 4,	1	Larch,	3000	J. Ream,	E—d,	Per Lot,	1700	1960		May 4,	490	0	0	1470	0	0			Settled by Bills at 4 & 8 months after date
...	...	2	...	500	...	...	...	260												
...	...	3	...	300	J. Morison,	E—d,	...	160	160		...	40	0	0	120	0	0			...
...	...	4	...	400	R. Murray,	L—e,	...	200	610		...	152	10	0	457	10	0			...
...	...	5	...	250	...	...	...	140												
...	...	6	...	450	...	...	...	270												
...	...	7	...	2000	J. Ramsay,	K—o,	...	1050	1650		...	412	10	0	1237	10	0			...
...	...	8	...	1000	...	...	...	600												
...	...	9	...	1500	J. Kemp,	L—l,	...	800	800		...	200	0	0	600	0	0			...
...	...	10	...	600	R. Webster,	L—e,	...	300	300		...	75	0	0	225	0	0			...
			Trees,	10,000					5480			1370	0	0						
Plantation of Gorry,	...	11	Scots Pine,	1000	J. Nicholson,	N—e,	...	310	960		...	240	0	0	720	0	0			...
	...	12	...	500	...	...	...	170												
...	...	13	...	500	...	...	...	150												
...	...	14	...	700	...	...	...	230												
...	...	15	...	300	...	...	...	100												
...	...	16	...	500	R. Reid,	L—d,	...	160	720		...	180	0	0	540	0	0			...
...	...	17	..	1000	...	...	...	340												
...	...	18	...	700	...	...	...	220												
...	...	19	...	300	S. Johnston,	W—e,	...	100	100		...	25	0	0	75	0	0			...
...	...	20	...	800	J. Grant,	G—n,	...	250	490		...	122	10	0	367	10	0			...
...	...	21	...	700	...	...	...	240												
...	...	22	...	2000	W. Stewart,	G—n,	...	650	1230		...	307	10	0	922	10	0			...
...	...	23	...	2000	...	...	...	580												
...	...	24	...	250	R. France,	E—h,	...	80	299		...	74	15	0	224	5	0			...
...	...	25	...	250	...	...	...	75												
...	...	26	...	250	...	...	...	70												
...	...	27	...	250	...	...	...	74												
			Trees,	12,000					3799			949	15	0						

2478. This, then, is the form of book in which we register our sales of timber by public auction; we have adopted it for a number of years, and have found it to answer all purposes admirably. The headings point out the different branches into which it is divided, so that little description is required in explanation. We shall, however, make a few remarks to show the way of going to work in putting down the particulars of a sale.

2479. The 1st column, as indicated by the heading, is for entering the names of the plantations in which the timber is sold; and the 2d, the date on which the sale took place. Here, then, from the reading of the first line, we find that the sale took place in the plantation called the Hill of Bands, and on the 4th day of May. The 3d column indicates the numbers of the respective lots sold; the 4th the kinds of trees the lots consisted of; and the 5th, the number of trees in each lot respectively; so that in continuing the reading of the first line, we see that the first lot consisted of larch to the extent of 3000 trees. The 6th column indicates that this lot was sold to John Ream, and the 7th that his residence is at E——d; the 8th, that the timber is sold *per lot*, without reference to any other specified quantity or mode of measurement; the 9th, that the entire value of the 1st lot, as purchased by him, is £1700. The first line finishes at this point because the same John Ream has bought also lot 2, which consists of 500 larch trees, sold to him at the price of £260. These two sums, then—£1700 for lot 1, and £260 for lot 2—make £1960 as the total amount of this person's purchase; and this is therefore set down in the 10th column, which is adapted by its heading for this purpose. Passing the 11th column, which is set apart for entering any discounts that may be allowed, we read in the 12th and 13th columns that on the 4th day of May, the day on which the timber is supposed to have been sold, John Ream paid, as the fourth part of the price of his purchases, £490, in conformity with the conditions of the sale. Next, from column 14th, we see at a glance that this purchaser is due after the sale, and after he has made his first part payment, £1470, which constitutes exactly three-fourths of the price of his purchases. Columns 15 and 16 are for use when further payments come to be made, and therefore, in the meantime, are left blank till full payments are made. But from the 17th column we see that John Ream settled for the balance due by him, by granting his bills for payment at four and eight months after the date of the sale, and so on with all the other lots as they are shown under the names of the different purchasers respectively. From this tabular statement, therefore, a most complete account is given of each of the lots sold, in a clear, distinct, and satisfactory manner for after-reference.

2480. We know of no system of book-keeping which is so well adapted to answer the purpose of sales by public auction as that given in the foregoing form, as it is simple and clear, as well as concise, and therefore taking up little space in a book.

2481. It is to be observed, under the 3d column, that the larch timber is embraced in the first 10 lots, and was therefore first sold; that the Scots pine timber commences at lot 11, and is embraced in the following lots to 27; and the number of larch trees (10,000), it will be observed, corresponds with the number stated in the estimate of proposed income stated under paragraph 2411 as proposed to be sold, and the number of Scots pine (12,000) also corresponds with the number mentioned in that statement. But on comparing the result of the sale with the sums stated as the value of the trees respectively in the estimate of the proposed income, it will be found that there is a considerable difference.

2482. Under paragraph 2411 it is set forth in reference to the income expected from the 10,000 larch trees, that their value might probably be £5000, and in reference to the 12,000 Scots pine trees, that their value might probably be £3600; while the result of the sale, in the 10th column, shows £5480 for the larch, and for the Scots pine £3799, thus making, as the sum realised in all, £9279—instead of £8600, as was expected—or £679 more than the estimated value. Such a result as this indicates often takes place at public sales, as, however judiciously any forester may value his wood, it may bring more or less, according to the demand for the sort of timber at the time of sale.

2483. Having made the foregoing remarks in explanation of the form of book for public sales of timber, we do not think it necessary to make any further remarks on the subject, but request the young forester to consider and study, very carefully, the character of the different books we have given copies of, for all the purposes of expenditure and income. Unless he do this, and get a clear view of the whole subjects the copies are meant to present to him, he will never be able to keep correct accounts, whether of expenses for work performed or of income from produce sold. The foregoing copies of books are all absolutely necessary for every forester to keep, in order to be able to lay before his employer a sensible and intelligent statement at the end of the year, of all the transactions and works he has had performed, and of all the produce he has sold. Without some such system, the business under his charge must eventually run into confusion.

2484. The books we have given copies of, and described, are as follows:—

1st, ESTIMATE OF THE PROBABLE INCOME FROM, AND EXPENDITURE ON, THE WOODS AND PLANTATIONS ON THE ESTATE OF LYNMORE, FOR THE YEAR FROM 30TH APRIL 1880 TO 1ST MAY 1881. This book may be of any convenient size to suit the extent of business likely to be performed, and ought at least to contain so many pages as to admit of its holding transactions for a considerable number of years, and it may be had to order, from any stationer in a large town, ruled as shown in the copy, bound and ready for use: of course, in the forester ordering such a book from a stationer, he will require to give him a specimen copy to guide him in the ruling of it. The principal headings may be all printed, which will give the book a neater and more business character.

2d, The Day-Labour Book (copy shown from paragraph 2417 for the first four weeks of the supposed year). This book should be made to contain the labour transactions of one year, and should be labelled outside Day-Labour Book, for the Woods and Plantations on the Estate of ——, for the year ——. Such a book may also be had from any stationer, by giving him a copy to rule from; and all the headings should be printed, which will be a saving of time to the forester, and be the means of preventing mistakes.

3d, Account of Day-Labour and Piece-Work performed in the Woods and Plantations, &c., as shown under paragraphs 2430 and 2431. This book should also be made to hold the transactions of one year, and, as in the case of the Day-Labour Book, should be labelled outside,—when, at the end of the year, both can be laid past as documents together, for the same year.

4th, The Cash-Book, as shown under paragraph 2443. This one may be of any convenient size to suit the transactions of the estate, and is most convenient when so large as to hold the transactions of a considerable number of years.

The four foregoing books are all that are necessary in connection with the labour department of the woods, as there cannot possibly take place any description of labour which may not be properly detailed in them, and attested by the parties performing it. With these general remarks on them, we shall proceed to give a similar short sketch in reference to the books for Income, copies of which have been described in their respective places:—

5th, Account of Sales of Timber by Private Contract, as shown under paragraphs 2455 and 2456. This description of book may be made either of dimensions sufficient to hold the sales of one year only, or those of several years, according to the business habits of the proprietor. We ourselves have ours of so many pages as to hold the sales of several years; and this, we think, is the most convenient way.

6th, The Ledger, as shown from paragraph 2461 to 2465. This is a book which requires to be generally pretty large, in order to admit of a few pages being set aside for each purchaser; and it should also be provided with an alphabetical index at the beginning, by which to find out the names of the parties to whom the wood is sold. This is of course managed by the parties' names being registered on the index, according to the first letter of their names; and where the parties' names are registered in the index, reference is made to the page of the book where their particular transactions are detailed.

7th, Account of Sales of Timber by Public Auction, &c. This description of book is a very important one on most wooded estates, and, therefore, it should be made of a pretty large size, and sufficient to hold the transactions of several years.

24n the Estate of Lynmore, *from the* 30*th April* 1880 *to* 1*st May* 1881.

N	6. Comparison of Actual and Estimated Income.													Remarks.
	me.	2. Estimated Income.			3. Sums under Estimate.			4. Sums over Estimate.			5. Difference betwixt Actual and Estimated.			
	d.	£	*s.*	*d*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	
Hill	0	5,000	0	0				480	0	0				
Gor	0	3,600	0	0				199	0	0				
Ada	0	625	0	0	250	0	0							£234, 15s. included in private sales.
Bur Cl La	6	700	0	0				124	15	6				
Ret Ed	0	400	0	0	45	11	0							
Dam Pl	4	200	0	0	15	9	8							
Ada														
	0							234	15	0				This sum, although realised from private sales, was estimated on public sales from Adam's Wood.
's	0	250	0	0				59	15	0				
Slug	0	560	0	0	120	15	0							The weight of bark actually got from these woods is 13 tons under that estimated for, and the price per ton is also 10s. under that estimated for.
Tho		60	0	0										
D		20	0	0										
D		5	0	0										
D		100	0	0										
Brai		120	0	0										
D	0	3	12	0										40,000 Scots pine were used in the Thortown Bridge enclosure, as per statement of expenditure on planting.
West	0	7	10	0										
	0	110	0	0										
	0	18	0	0										
	10	11,779	2	0							746	9	10	Over.

COMPARAmore, *from the* 30*th April* 1880 *to* 1*st May* 1881. *Cr.*

	l and Estimated Expenditure.			
	ums under Estimate.	Sums over Estimate.	Difference betwixt Actual and Estimated.	REMARKS
EXPENDITUR	£ s. d.	£ s. d.	£ s. d.	
Salaries a				
Forest				
Do.				
Assist				
Do.				
Wood				
Clerk				
Fencing:—				
Braid				
3		6 0 5		
Thort				
	51 6 3			
Gener				
	20 6 8			
Enclo				
E		4 17 0		
			60 15 6	Under.
Draining.				
Braid				
3		17 2 0		
Thort				
	38 3 0			
			21 1 0	Under.
Planting:				
Braid				
	9 2 6			
	1 0 0			
Thor				
		7 10 0		
		1 0 0		
			1 12 6	Under.

te of Lynmore, *from the* 30*th April* 1880 *to* 1*st May* 1881. *Cr.*

n of Actual and Estimated Expenditure.				
	Sums under Estimate.	Sums over Estimate.	Difference betwixt Actual and Estimated	REMARKS.
	£ s. d.	£ s. d.	£ s. d.	
		9 11 6		
			9 11 6	Over.
	13 0 0			
			13 0 0	Under.
		3 2 9		
			3 2 9	Over.
		1 19 0		
	6 9 3			
		3 17 6		
	4 10 6			
			5 3 3	Under.
		4 2 5		
		0 12 9		
	0 1 2			
	10 6 7			
	2 0 6			
			7 13 1	Under.
		2 10 0		
			2 10 0	Over.
		5 15 0		
			5 15 0	Over.
	29 0 0			
		74 0 0		
			45 0 0	Over.
		4 1 9		
			4 1 9	Over.

Compi ynmore, *from the* 30*th April* 1880 *to* 1*st May* 1881. *Cr.*

	ual and Estimated Expenditure.			Remarks.
	Sums under Estimate.	Sums over Estimate.	Difference betwixt Actual and Estimated.	
	£ s. d.	£ s. d.	£ s. d.	
Pru	3 4 8			
		6 2 6		Not estimated for.
			2 17 10	Over.
Nut				
	0 1 5			
		0 5 0		
		0 15 0		
		2 10 0		
			3 8 7	Over.
Nu	6 5 0			
	1 3 0			
		2 1 9		
		0 11 5		
		1 15 0		
			2 19 10	Under.
		5 15 6		
		7 11 10		
	7 14 6			
		6 17 0		
		2 19 0		
	0 17 6			
		1 10 0		
		1 3 6		
	2 5 0			
		5 12 7		
		1 5 6		
	0 2 6			
		7 3 7		
			28 19 0	Over.
			6 18 9	Under.

2486. All the seven books referred to should be well bound, and never slimly in paper boards, as, when they are so, from the great amount of handling they must necessarily get, they soon become shabby-looking, and, in fact, are apt to get torn, so that it is always a matter of economy to have all such account-books bound in leather.

2487. Although the seven foregoing books are sufficient for all purposes of keeping accounts, in regard to the expenditure and income of woodlands, still, the book-keeping of the forester could not be said to be complete with them alone, inasmuch as, at the end of each year, he must render to his employer a correct and formal account of all the transactions he has performed during the year past. For this purpose we have in use other two books—one called "Comparative Statement as to Estimated and Actual Income and Expenditure," and another called "Statement of Income and Expenditure." A copy of the former is annexed.

2488. We shall now take a glance at the foregoing statement, with the view of giving a short explanation of what it is meant to represent, and show the use of keeping such a book. The object of it is to embrace, in one comprehensive statement, the transactions of each year, after they have been all performed in accordance with the scheme supposed to be drawn up at the beginning of the year, in the way shown in the statement called the "Estimate of the Probable Income and Expenditure," &c., a copy of which has been given as the first book in this system of book-keeping. But it is designed not only to embrace all the transactions of the year, but also to compare the sums actually received and expended on each branch at the end of the year with those that were estimated as probable at the beginning.

2489. Taking a glance at the debtor or income side of the statement just given, we see that the first column indicates the different woods from which produce was sold; and the second column, the description of produce. The third column indicates the quantities of trees sold by public auction, and the sums actually realised for each sort and quantity, and this of course should correspond with the results stated in the public-sales book. The fourth column, again, indicates the quantities sold by private contract, and the sums actually realised for each sort and quantity. This of course should correspond with the details and results of the private-sales book, and with those detailed in the sales entered in the ledger. The fifth column shows the entire quantities sold, and the whole of the money realised for them, and into this column is entered the value of all plants that have been removed from the nursery to the enclosures.

2490. Under the great column, No. 6, the comparison betwixt the actual and estimated income is shown, and the difference betwixt them respectively. Thus, in the first column under No. 6 it is shown that the sum actually received for the 10,000 larch-trees sold from the Hill of Bands is £5480; in the second, that £5000 only was estimated as their value; and from the fourth, that they realised £480 over their estimated value; and so on with the other items detailed.

2491. The result of the debtor side of this statement is, that it is seen at a glance, under column third, that £9654 was realised during the year from public sales, and under column fourth, £2427, 9s. 10d. from private sales. But besides this, it is shown under 1 of column six, that £12,525, 11s. 10d. was realised as the whole value of produce, of all sorts, during the year; and under 2 of column six, that only £11,779, 2s. was expected to be realised; while under 5 of column six it is brought out that £746, 9s. 10d. has been realised over and above what was expected at the beginning of the year, and as stated in the estimate of probable income and expenditure for the year.

2492. On the creditor or expenditure side of the statement, the same mode of comparison is followed in regard to the sums under the different branches there set forth; and as we have said so much in explanation of the income side, we think it unnecessary to enlarge in reference to the expenditure, as the different headings speak for themselves. We may, however, just make a short reference to one or two of the branches.

2493. Under the head "Salaries and Allowances" it will be seen that the actual expenditure at the end of the year was exactly the same as that estimated for at the beginning of it.

2494. Under the head "Fencing" it is brought out that the wire-fence which was erected on Braidwood Hill enclosure cost £6, 0s. 5d. more than was estimated for; that the stone wall erected on Thortown Bridge enclosure cost £51, 6s. 3d. less than estimated; that the general repairs of fences cost £20, 6s. 8d. less than estimated; that the repairs of gates cost £4, 17s. more than estimated; and that, on the whole, the fencing cost £60, 16s. 6d. less than was expected at the beginning of the year.

2495. That some difference, less or more, will occur in all such estimates, must be expected by every judicious man, as it is not in the nature of things that, at the beginning of the year, when the works are merely in contemplation, the forester should know the exact sum that each is to cost. It is, therefore, not to be attributed to want of judgment in the forester although he should be even 15 per cent from the estimate on some particular works, if, on the whole, he come near to the truth.

2496. Having made the foregoing remarks in reference to this statement, we shall now conclude by pointing out that the result of the comparison of the actual and estimated expenditure, as set forth in reference to all the different branches, is, that while £3791, 14s. 10d. was allowed for them all at the beginning of the year (see details under paragraph 2411), they cost in all only £3784, 16s. 1d., or £6, 18s. 9d. less than was expected.

2497. The advantages of keeping a book in which to register such a comparative statement in reference to each year's transactions, must appear evident to every one who has at all paid attention to the keeping of correct accounts of estate management. No proprietor ought to be without such a statement from his forester at the end of each year's transactions, as he can see at a glance from it whether his forester has realised the income he expected, and whether he has carried out the works he proposed at such a cost as he anticipated; and from having such, he can always look back upon it as a guide to himself in proposing such works for the future. But besides, the keeping of such a book as has been here exemplified, will compel the forester himself to act with judgment in all he undertakes, well knowing that his employer will call him to account for any very great difference that may arise, whether in reference to income or expenditure. The next book, and the last one we have to refer to, is that which shows the actual state of income and expenditure for the year. A specimen of this, grounded on the copies of books and statements already given, will be found on next page.

2498. Under paragraph 2500 of the statement just given, the sum of £12,209, 9s. 10d. is brought out as the gross amount which the forester is supposed to have received during the year, and for this amount, therefore, he has to account to his employer. We ought to remark here, however, that this amount of income is less than that stated in the comparative statement (under paragraph 2485) by £316, 2s. The reason of this is, that in the comparative statement the latter sum is entered in the actual income as the value of plants supplied to the enclosures from the nursery. This amount, it must be kept in view, however, was not received by the forester, but was merely stated in the comparative statement, to show the real value of the plants reared in the nursery, and planted out by him. But, deducting this sum of £316, 2s. from the gross income of £12,525, 11s. 10d., stated as the gross income under paragraph 2485, we have exactly £12,209, 9s. 10d. as the real or actual income for which the forester is supposed to have to account, and this corresponds with the income stated under paragraph 2500.

2499. On the creditor side of the statement, the different accounts are branched, according to the work they have been paid for; and of course the amount of all the vouchers for the different branches of accounts must correspond with the total of the sums paid out by the forester for the year, and as entered in his cash-book.

2500. LYNMORE WOODS

Dr.

RECEIPT AND EXPENDITURE, *from the*

To RECEIPT—		
Sales of Produce by Public Auction.		
From sales of larch and pine timber, in the plantations of Gorry and Hill of Bands, on the 4th May 1880, as per public-sales book, . . .	£9279 0 0	
From sales of oak timber in Adam's Wood, on the 24th August 1880, as per public-sales book, .	375 0 0	
		£9654 0 0
Sale of Produce by Private Contract,		
As per private-sales book, ...	2427 9 10	
		2427 9 10
Rent of saw-mills for the year ended 30th April 1881, ...		110 0 0
Rent of cottages for the year ended 30th April 1881, ...		18 0 0
Carry forward, . . .		£12,209 9 10

AND PLANTATIONS.

Cr.

30th April 1880 *to* 1*st May* 1881.

No. of Voucher.	Expenditure—		
	Salaries and allowances—		
1.	John Baxter, forester, for year ended 30th April 1880,	£300 0 0	
2.	Do., allowance for horse, do.,	30 0 0	
3.	George Gillian, assistant to forester, for year ended do.,	100 0 0	
4.	Do., allowance for horse, do.,	30 0 0	
5.	William Turnbull, clerk to forester, do.,	60 0 0	
6.	Peter Sangster, allowance for looking after western district, one year, ended do.,	40 0 0	
7.	George Jopp, do. eastern district, do.,	40 0 0	
8.	Robert Bruce, do. northern district, do.,	40 0 0	
9.	Maxwell Hay, do. southern district, do.,	40 0 0	
			£680 0 0
Vouchers in Monthly Pay-List.	Pay-Lists of day-labour and piece-work, for the month ended 26th May 1880,	193 14 6	
	„ 30th June „	386 15 6	
	„ 28th July „	170 10 9	
	„ 1st Sept. „	163 2 6	
	„ 29th do. „	235 9 4	
	„ 3d Nov. „	142 7 6	
	„ 1st Dec. „	167 0 0	
	„ 29th do. „	150 2 10	
	„ 1st Feb. 1881,	96 15 7	
	„ 2d March „	135 19 4	
	„ 30th do. „	296 7 3	
	„ 30th April „	141 18 7	
			2280 3 8
	Young trees for nursery—		
10.	John Stoddart, Muirhead,	67 12 9	
11.	James Maxwell, Newtown,	30 10 3	
12.	George Simpson, Rafford,	23 13 1	
			121 16 1
	Carriage of young trees—		
13.	Lauchlan Grant, Newtown,	2 7 6	
14.	Wm. M'Kenzie, Lynstock,	5 19 3	
15.	George Sutherland, Mayen,	1 17 1	
			10 3 10
	Carpenter-Work—		
16.	John Mathieson, Newlands,	5 18 0	
17.	Robert Welbeck, Bencroft,	4 6 0	
18.	Samuel Murison, do.	0 13 0	
			10 17 0
	Smithy-Work—		
19.	Robert Dickson, Rosieburn,	4 8 6	
20.	Donald Fife, Craigstown,	5 17 0	
21.	Alexander Laing, Smiddyseat,	2 13 6	
			12 19 0
	Lodges, Repairs of—		
22.	James M'Kinnan, mason, Pitgair,	62 14 10	
23.	George Urquhart, carpenter, do.	15 13 4	
24.	William Sim, painter, do.	1 3 4	
			79 11 6
		Carry forward,	£3195 11 1

LYNMORE WOODS

Dr.

RECEIPT AND EXPENDITURE, *from the*

To amount brought forward,	£12,209	9	10
	£12,209	9	10

AND PLANTATIONS.

Cr.

30*th April* 1880 *to* 1*st May* 1881—(*continued*).

No. of Voucher.			
	By amount brought forward,		£3195 11 1
	General Stationery—		
25.	Samuel Walker, ...	£1 3 6	
26.	Wm. Smith, jun., ...	7 1 2	
27.	Robert Dunbar, ...	5 11 4	
28.	George Fowlie, ...	1 15 10	
			15 11 10
	Expenses on Sales of Timber—		
29.	George Ramsay, advertisements, .	6 2 3	
30.	Wm. Walker, do. . .	6 12 9	
31.	Wm. Murison, sale dinners, . .	15 12 7	
32.	George Ramsay, printing catalogues, .	6 5 6	
33.	James Skinner, auctioneer, . .	6 14 6	
34.	Do. do. . . .	3 3 0	
			44 10 7
	Implements, Ironmongery, &c.—		
35.	John Hanny, ...	3 19 4	
36.	Alexander Thomson, ...	3 3 2	
			7 2 6
	Travelling Expenses of Forester and Assistant—		
37.	John Baxter, ...	19 11 5	
38.	George Gillian, ...	11 4 1	
			30 15 6
	Criminal Prosecutions—		
39.	Walter Gregor, ...	27 5 6	
			27 5 6
	Keep of Forest Work-horse—		
40.	Robert Manfred, ...	7 10 0	
41.	James Strachan, ...	1 2 0	
42.	Thomas Low, ...	11 9 6	
43.	James Shaw, ...	6 8 6	
			26 10 0
	Wages of Carter—		
44.	James Parker, ...	30 0 0	
			30 0 0
	Saddlery—		
45.	George Yeats, ...	4 3 6	
			4 3 6
	Rates and Taxes—		
46.	William Inglis, assessor, . . .	87 3 7	
			87 3 7
			3468 14 1
	1880. Nov. 11.—By Cash remitted to J. E., .	4000 0 0	
	1881. Nov. 20.—By do. do. do. . .	4000 0 0	
	„ 30.—By Balance on hand, as per Bank-Book, ...	740 15 9	
			8740 15 9
			£12,209 9 10

2501. The first branch of accounts is that for "Salaries and Allowances," and for this there are nine vouchers in all. In making up this statement, the forester should number on the back each voucher with a number correspondent to that which he gives it in the statement, so that he can lay at once his hand upon it from its number, independent of its description on the back. The amount brought out as having been paid for salaries and allowances (£680), corresponds with that brought out for the same branch under paragraph 2485.

2502. The next branch of the account is that of "Day-Labour and Piece-Work," the vouchers for all of which are understood to be kept in the book called Pay-List of Day-Labour and Piece-Work, a copy of which is given under paragraphs 2430 and 2431. In this statement are embraced all accounts paid for Fencing, Draining, Planting, Hedging, Repairs of Water-Runs, Saw-Mill Dams, Roads, &c.; Felling and Preparing Timber, Stripping and Curing Bark, Thinning, Clearing, and Burning Rubbish, Pruning, and all Nursery-Work; all as detailed under paragraph 2485 of the Comparative Statement of Expenditure.

2503. All the other branches of accounts detailed in this statement show for themselves, and are simply different accounts as paid by the forester during the year, arranged according to their characters, and numbered for convenient reference.

2504. From this statement it is brought out that the forester, during the year, is supposed to account and to show vouchers for having paid out in all, for the different works, the sum of £3468, 14s. 1d.; that he has paid his employer, at the dates mentioned, £8000; and that he has on hand at the time he is supposed to render this account, £740, 15s. 9d. All these sums added together, then, correspond with the sum of £12,209, 9s. 10d., stated as the gross income on the debtor side of the statement; which, therefore, shows that the transactions are correct.

2505. The sum of £3468, 14s. 1d., stated as the gross sum expended by the forester during the year, will be found not to correspond with the sum brought out as the total expenditure in the comparative statement under paragraph 2485, as in the latter the sum of £316, 2s. is entered as the value of plants removed from the nursery, which sum, as before stated, was not paid out by the forester, but merely entered to show the actual value of the plants. Both statements, however, will be found to correspond by deducting the sum last named from the gross amount set down as the actual expenditure under paragraph 2485; and with this explanation, we think enough has been said on the subject of book-keeping.

2506. The forester, it is understood, renders such a statement as has just been described, at the end of each year, to his employer, with all the vouchers for the different accounts; and on rendering it, he should register a copy of it in a book for the purpose, so that he at all times knows what he has done and stated, and can refer to it when necessary.

2507. With such a set of account-books as we have given copies of and described, any forester may keep his business as well as any accountant could.

2508. There are other two books required—viz., the Nursery-Book and the Bank-Book; but the former is a mere keeping of the number of plants sent out and bought in, and is so simple that any forester can sketch out such for himself. The latter, on the other hand, is a mere pass-book, kept between the banker and the party lodging the money, and need not be referred to here.

CHAPTER XXVI.

SECTION I.—THE REPAIRING OF THE BANKS OF SMALL RIVERS.

2509. Although not directly connected with arboriculture in the proper sense of the term, yet the repairing of the banks of rivers, where they have been injured by floods, is a duty which generally falls to be performed by the forester. In this section, therefore, we shall make a few remarks as to the way in which such work ought to be attended to,—not by entering minutely into the details of the subject, but merely by giving such general hints as will lead foresters who may have such work to do, to have it done in a suitable manner.

2510. The breaking down of the banks of a river generally takes place while it overflows its banks after a heavy fall of rain, and chiefly occurs where any considerable obstruction prevents the proper flow of the water, or where a sudden bend in the river causes the force of the current to undermine the bank, at the spot where the bend occurs. Damage to river-banks from obstructions and sudden bends is most to be feared where the river is rapid running, and therefore where it has the greater force to undermine and wash away the banks. The banks of all rivers are more or less liable to fall away gradually in pieces, and especially so where the subsoil is of a shifting gravelly nature. Where rivers run through an estate, therefore, it will be the duty of those in charge to see that their banks are kept in proper sound condition.

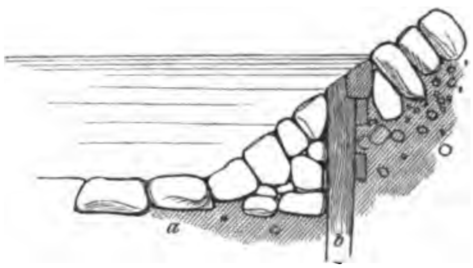
2511. One great cause of damage to river-banks is the too frequent neglect of keeping the bed of the river clear of all obstacles that would in any way hinder the free flow of the water. We frequently see large roots, or even trees, and large stones lying in the bed of a stream. These should be removed as soon as practicable, as they are a fruitful source of damage, by impeding the natural flow of the stream and forcing the water against the banks, which would otherwise flow freely on.

2512. Where the banks of a river have been injured by floods,

&c., a very good plan is to form what is called *piling* along the water-line of the part where any breach has occurred. This is done by driving in a row of strong wooden posts along the water-line, at say 9 inches apart, and from 2½ to 3 feet into the soil below the water—keeping them, when driven, as high as the level of the banks. After this is done, a couple of strong rails are nailed on the piles—one about 3 inches from their tops, and the other close to the level of the river-bed, and this in order to keep them in line and position. Brushwood is then firmly packed in behind the piles until it reaches the surface, when earth can be placed on the top, and firmly trodden down and brought to the level of the surface, when the whole part should be covered with turfs. Spruce branches do well for packing behind the piles, and if properly put in and the piles firmly driven, the whole will last for many years, and serve to keep the bank from being washed away by the force of the current.

2513. If stones are plentiful in the locality where river-banks require to be repaired, a very secure and lasting mode of repair is to form rubble facing along the broken portions of the banks; and in this way, after properly levelling and smoothing the injured parts, and giving them a consistent slope, large stones should be built on them edgewise, beginning on the firm bottom, and placing them regularly along the sloped bank, as far up as may be necessary to protect the injured parts, all in a similar way to causewaying a footpath. The stones at the bottom should be extra large, and fixed in the bed of the river as shown at *a*, in the annexed figure; and they should be built up to such a height as will keep them above the high-flood mark. As the water sometimes undermines and displaces the stones, it is generally necessary to support the work by a row of heavy piles driven in on a line with the stream, and at 3 feet apart, as shown in the figure at *b*; so that, although the building in front should be disturbed, the piles will keep the bank still good behind. In order still further to secure the stability of the structure, a heavy beam of timber should be fixed on its upper end, parallel to the building, and close to it, in order to prevent the action of the water undermining the building. If the bed of the river is not of a very solid character, however, this sort of structure would not stand, but would ere long be undermined and

Fig. 177.

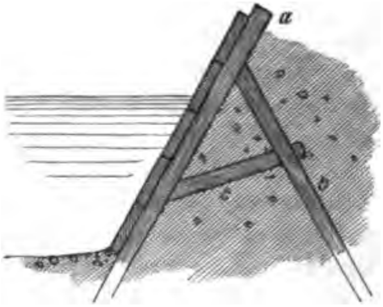


washed away by the action of repeated floods. Therefore, in all cases where the bed of the river is gravelly or sandy, the injured banks should be repaired by wooden piles, as referred to under paragraph 2512.

2514. A common method, where a piece of a river-bank has been washed away, is to erect a *jetty* or breakwater, just above the breach, for the purpose of directing the flow of the water from it. As a temporary cure, this is sufficient at the time, and may answer the purpose until a more substantial protection has been erected. This breakwater can be made of stones, or of brushwood kept in place by piles; and should be erected at such an angle as to throw the current of the stream well off the broken part.

2515. Another temporary method of protecting injured parts is to put up a wooden facing upon the spot, as shown in fig. 178. Piles are driven into the ground at an angle, as shown at *a*, and these are supported by other piles, *b*, while a support, *c*, is nailed across between the two, in order to keep the whole firmly together. Strong planks are then nailed on the piles, *a*, and the whole firmly packed behind with earth to make it secure. This is an expensive protection, but is to be recommended where a protection is wanted immediately.

Fig. 178.



Having given the foregoing hints as to the repairing of the sides of small rivers, such as are generally found running through landed estates, we shall conclude this section by a few additional remarks on the subject.

2516. In repairing the banks of streams in any of the ways set forth in the foregoing part of this section, great attention should be paid to the proper turfing of the tops and ends of the parts operated on; as, if this is neglected, it is almost certain that the water of the next flood will make inroad upon the yet soft matter put in behind the facing. To prevent any accident of this nature, all the turf laid on the top parts, and behind the front erections, should be put on very closely and firmly, and made level with the natural surface on their backs and ends; while the ends of the structures erected in front of them should be well secured by piles, driven in so as to render these parts proof against the inroads of after floods.

2517. When any spot becomes injured on the banks of a river, it should be at once attended to and made good, as if it be left unprotected, as is too often the case, the damaged part will gradually become larger, and therefore the more difficult to deal with.

2518. Large trees should not be allowed to grow close on the sides of water-streams, as their roots form an obstacle to the free current of the stream, and therefore eddies are formed, and the banks undermined, and gradually they fall in.

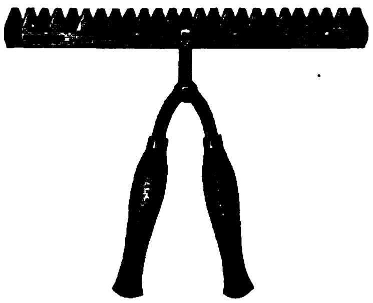
2519. Wherever the banks of a stream have a tendency to fall in, they should be planted with *willows*, as the very fibrous roots of this class of plants very soon occupy every portion of the soil, to a depth of from 3 to 4 feet, and therefore keep the banks of rivers good against the rushing of water. Willows planted in such a situation should not, however, be allowed to grow up as trees, but merely as osiers, and should be cut over every season, in order to keep them down, and from forming any obstacle to the current of the water while it is in flood.

SECTION II.—FOREST TOOLS AND MACHINES, PARTLY OF RECENT INTRODUCTION, NOT REFERRED TO IN THE FOREGOING SECTIONS OF THIS WORK.

2520. Although we have in the foregoing part of this work referred to and described the uses of most of the common tools used in the various operations of forestry, still we think it necessary to devote a short section to a brief description of a few forest tools which are in general use, and to that of some forest machines which have been recently introduced, but none of which have been yet noticed in the preceding pages. Of late years forestry has undergone many changes for the better, but in the department of tools, and of machines adapted to forest operations, it must be admitted that until very recently comparatively little has been effected in the way of improvement; and it is for this reason that we purpose to bring under notice here the appliances we are about to describe. Before attending to this, however, we may just state that the machines of recent introduction, and represented by figures 179, 180, 183, 184, and 185, have all been tried to such an extent as to give promise that they are likely ere long to come into general use; but before we can recommend them with full confidence to our readers, we advise foresters and others interested in such machines to see them put into practice, for further proof of their adaptability to the works for which they are severally intended. The following are the tools and machines we have to refer to:—

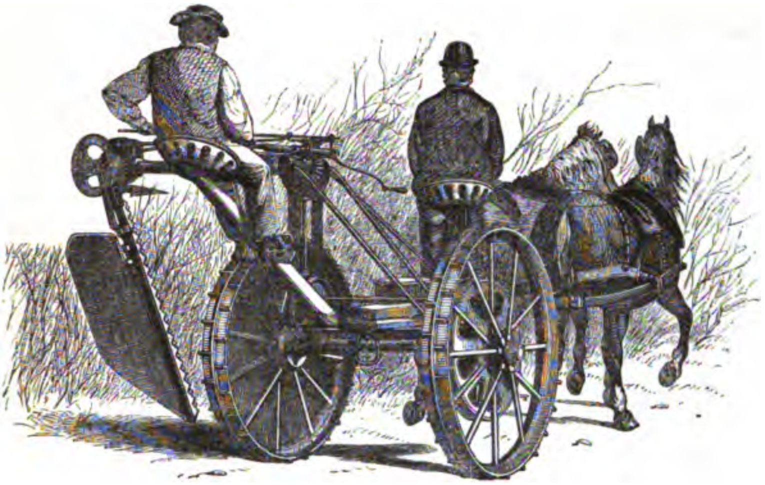
2521. Fig. 179 represents a new hedge-cutting machine lately introduced by Mr Alfred Ridgway, which is said to do its work well and expeditiously. It is constructed on a similar principle to the common reaping machine, with handles the same as those of a pair of hedge-shears. Both motions of the machine cut the hedge, by which plan the work can be done more quickly than were it only to cut one way. In using it, the left hand guides the machine to its work, while with the right one the handle is moved backwards and forwards, giving it the full play of the top knife. In this way a man can move forwards along the hedge at a slow pace, cutting the hedge as he goes, and can either cut lengthways with the hedge, or from near the bottom upwards. The best way is first to cut, horizontally, the lower part of the hedge, and afterwards the upper part can be cut in a perpendicular manner. We have no hesitation in recommending this machine for use upon evergreen hedges that are kept regularly trimmed, as we know from experience that it is well adapted for such work. It will cut twigs of a fair thickness, but should not be used unless upon hedges that are kept regularly cut every season. We may mention that only the top knife requires sharpening, which may be done with a file in the same way as is done in sharpening the knife of a mowing machine. The machine can be had to cut either 1½, 2, or 3 feet in width, as may be required; but we are of opinion that for general purposes the one cutting 2 feet in width will be found to be the most useful.

Fig. 179.



2522. Another hedge-cutter of very recent introduction is what is known as Hornsby's hedge cutting and trimming machine. As yet this machine is new, and to a certain extent untried. As, however, it promises to be a great saving of labour, and an expeditious mode of doing the work of hedge-cutting, we think it right to bring it under the notice of landed proprietors, and of foresters who have the charge of large extents of hedging to be cut annually. Fig. 180 will give a good idea of this machine. It is manufactured by Messrs Richard Hornsby & Sons, implement makers, Grantham, and while in work is drawn by two horses, in a similar fashion to a reaping or mowing machine. We take the following from a description kindly sent us by Messrs Hornsby: "The machine is mounted on two road wheels of large diameter, to secure light draught. Both wheels are employed in driving the working parts, the motion being communicated by an arrangement of gearing to one of a pair of knives, similar to the knives of mowers and reapers, but larger, and of greater strength. These knives are carried by a sliding-bar projected from the side of the machine. This bar, with the cutting apparatus, is so arranged as to be capable of ready adjustment to suit different circumstances; the entire machine, when set for work, being under complete control of the man in charge, who rides upon a seat conveniently placed for making all necessary adjustments. The cutting apparatus can be raised to any required height, to suit high or low hedges, or the level of the ground on which the machine may be travelling. It can also be set at any required angle, to cut more or less off the hedge, and to reduce its height or alter its shape, as may be desired. Both sides of the hedge may be cut from the same side, so that the machine may be kept on that side which is most convenient. The side of the hedge nearest to the machine is usually cut first, and then the bar lifted over the hedge, and the angle of inclination reversed, so as to cut the other side. The top may afterwards be trimmed if required, by setting the cutting-bar straight out from the machine, and the height the hedge is required to be left. The hedge when cut is Λ-shaped, of any required width at bottom, and of any height."

Fig. 180.



The foregoing description renders it unnecessary for us to say much more on the subject, but only to mention that two men are required to work the machine,—one to drive, and another to manage the cutting. It is strongly constructed, and adapted to cut hedges having their side-shoots of several years' growth. Although, as we have already said, this machine is as yet only new and almost untried, yet we believe that, with a few improvements, the necessity for which can best be found out by fair trial, it will in the future come to be a very serviceable machine for hedge-cutting.

2523. We shall next refer to a useful implement called *one-hand* pruning-shears, used chiefly for the purpose of cutting shoots of evergreens. They are very simple in construction, and are made to open by a spring, while the closing is done by the hand pressing them together. We have used them frequently for pruning evergreens, and find that they are well adapted for the purpose—being strong, and yet suitable for carrying in the pocket. They will cut a branch of nearly an inch in thickness without any injury to the spring, and are easily kept in good condition. They may be had from Messrs Saynor, Cooke, & Ridal, Paxton Works, Sheffield. We would recommend every forester to use this article where he has any considerable extent of laurels, &c., to prune.

2524. Another very useful tool for pruning is what is called the *pole-saw*. Although not of recent introduction, we take the opportunity of bringing it under the notice of foresters here, as a necessary requirement where branches have to be cut at a considerable height, and where the pruning-chisel cannot be well put in use. This saw cuts only downwards, and has a long handle fitted to it of any convenient length. The blade may be fixed to the handle at any angle to suit the case in hand in respect to pruning, and is made of cast-steel, 2 feet long, and tapers from the lower end to the point. With this description of saw, branches of any ordinary thickness can be cut, and at a considerable height above the operator.

2525. A useful straining-screw for wire-fences is shown in fig. 181. This requires little explanation beyond what is conveyed in the illustration, which at once gives a good idea of the mode of working. It is only necessary to say that the end of the machine at *a* being placed against the post, the wire is passed through the opening there, and fixed to the vice *b*, by means of a screw-bolt and nut, after which it is tightened up by turning the handle *c*, when the wire can be keyed up and fixed round the post in the usual way. This is a convenient straining machine for any kind of wire-fence, and is manufactured by Messrs Bayliss, Jones, & Bayliss of Wolverhampton.

Fig. 181.

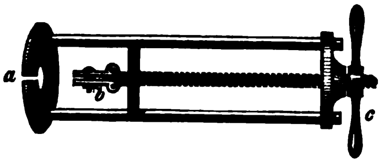
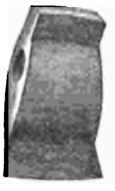


Fig. 182.



2526. The Canadian axe is one which in our opinion should be more used in our woods than it is at present. The annexed figure is a representation of this axe without a shaft. It is wedge-shaped, and when shafted with a clean piece of ash or hickory, forms one of the handiest and most powerful implements that can be put into the hands of a woodman. It can be had of different sizes and weights, to suit circumstances, and is sold by all the principal manufacturers of edged tools.

2527. For pruning trees at a considerable height from the ground, the *Standard tree-pruner* has lately been introduced by the Standard Manufacturing Company, Derby. Figs. 183 and 184 represent both ends of this pruner, which is of very simple construction—somewhat in the style of the averuncator, referred to in another part of this work. It consists of a pole, hook, metal rod, lever, and blade. The hook is of steel, and is made double, so that the knife works *in* the hook. The knife is thus supported on both sides, and can be made very thin, thereby reducing the resistance of the wood, and making a clean and smooth cut. The knife is connected with, and operated upon by, a metal rod, which gives a great degree of power; whilst the branch, being encircled by the hook, is altogether under the control of the operator, and cannot escape until the portion to be removed is severed. The whole is very light and easily wrought, and can be had with any length of pole.

Fig. 183.

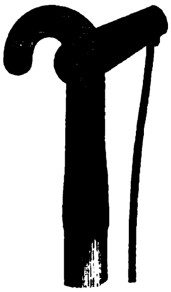
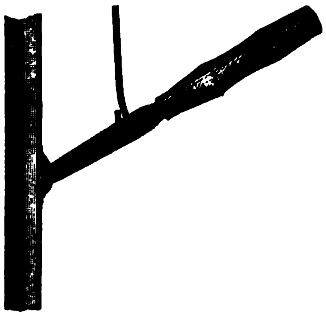
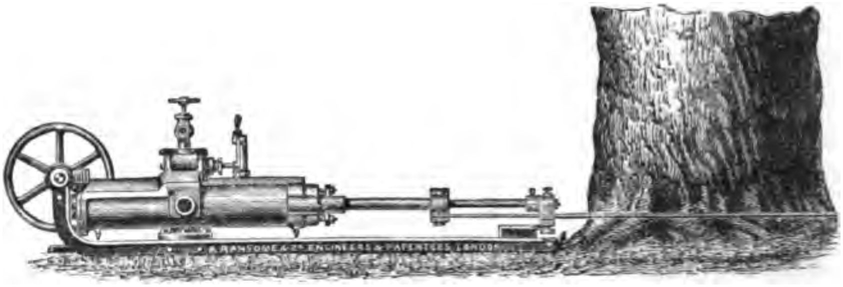


Fig. 184.



2528. We will conclude this section by referring to a steam tree-feller which has lately been invented and brought out by Messrs A. Ransome & Co., Stanley Works, Chelsea. This is the first machine of the kind that has yet been used for the purpose of felling trees, but with what success we are not yet in a position to judge, seeing that it has not yet been used to such an extent as to enable the public to form a decided opinion. The invention seems a good one, however, and we may reasonably hope that it will have more attention paid to it by foresters and others than it has hitherto had. Fig. 185 is a side view of this tree-feller, as it is placed at the root of a tree ready for work. It consists of a steam cylinder of small diameter, so arranged as to move upon a pivot on its centre, this pivoting motion being easily worked by the hand. The saw is fixed to a piston-rod, and is kept in its proper place by guides, and in this way it cuts through large-sized trees, without altering the position of the machine. The steam is supplied through a pipe from a portable boiler, placed at a convenient distance apart from the tree. With a long steam pipe, this boiler does not require to be removed until the tree-feller has operated upon a number of trees within the radius of the pipe. The feller can be carried about strung on poles by four men, and is easily set to the root of the tree and put in motion. Besides its use for felling trees off root, it can be so arranged as to be used for cross-cutting them on the ground as well; and as the machine works rapidly, it may be made to go through a great deal of work in a day. As we have already said, this machine is yet new in the world of forestry, and until it has received a fair trial, and had some well-applied tests, we cannot be expected to say much regarding its merits. We, however, do not hesitate to introduce it here, as well worthy of the best attention of those who are engaged in the cutting of large quantities of timber.

Fig. 185.


R. RANSOME & Co. ENGINEERS & PATENTEES LONDON

2529. There are other tools of different descriptions being invented from time to time for the use of the forester, but as they are either of little consequence, or merely some other form of a tool already in use, we think it unnecessary to refer to such here.

SECTION III.—THE FUTURE OF ARBORICULTURE.

2530. The ameliorating effect of arboriculture, when judiciously applied, on the climate and soil of a country, is beginning to be acknowledged by the wise and learned of the age we live in. Men of all ranks and positions will be found to admit that woodlands are of infinitely more importance in the economy of any nation or country than they have hitherto been acknowledged to be. Seeing this, therefore, there can be no doubt that we are rapidly approaching the time when the planting and distribution of trees, and the general operations of arboriculture, will be conducted in accordance with well-defined natural laws, and therefore elevated to the position of a science, as its importance demands. Great improvements have taken place in this department of rural economy within the last forty years, but much greater still will be the advances in the art within the next twenty years or so. Hitherto the improvements that have been effected in arboriculture have been mainly brought about by practical foresters, without the application of much scientific knowledge; but now that foresters in general are becoming better acquainted with the laws of nature, and are being so ably assisted in their observations by men of science, it is but reasonable to infer that, by the end of the present century, forestry, and its effects on soil and climate, will be much better understood than it is now, and will have emerged from the comparative mistiness that at present hangs over it, and be brought out into a degree of light wherein it may be clearly read in the book of nature.

2531. The indiscriminate clearing of forests which has been going on in all parts of the civilised world is now being looked into and condemned. This, for some time past, has drawn the attention of scientific men to its effects; which are to lessen the regular supply of moisture to the land, and consequently to render it very much less fertile to the agriculturist. But to be more explicit on this point, the want of trees increases both the heat and the dryness of the air, and this dryness lessens the amount of vapour which is necessary for the health of vegetation. Now, as it is well known that trees act as coolers of the surrounding air, by their shading the land from the sun's rays, it follows that a certain proportion of every country—some less and some more, according to position—requires to be kept under woods and plantations, in order to obviate too much dryness, and to maintain a due amount of moisture for the health of agricultural crops. Then the great and all-important question is, what proportion of a country should be kept under trees—of course regularly dispersed over it—and what proportion should be kept as arable, with a view to maintaining the highest possible degree of fertility in the cultivated portions of the land, and at the same time the state of the air which is most conducive to the health of the inhabitants? This is a question which we cannot yet answer satisfactorily. Indeed, before it can be satisfactorily answered, many and extensive experiments will have to be made on the subject, and it remains for the future of arboriculture to work out this problem, which can only be accomplished under a well-directed scheme, yet to be laid down and carried out, for the purpose; and certainly the sooner the better.

2532. In carrying out a system of experiments for ascertaining the proportion of land that should be kept under trees in any particular country, and in each particular part of the same country, they would require to be conducted under the superintendence of a well constituted society of scientific men, who would have their agents in all parts of the country, prepared to carry out their instructions with proper instruments, and who would receive from their agents, and present to the public, at regular stated intervals, the results of their observations on the subjects of the barometer, thermometer, hygrometer, winds, &c. &c. In attending to such observations, they would require to be made on woodlands, on open lands, on dry lands, on wet lands, on marshy lands, on water, by the sides of rivers, by the sides of lakes, and on all the various elevations embraced in the country, so that deductions might be drawn from comparisons. And not only these, but also the extent of each particular character of surface experimented on would require to be carefully noted, together with the geological character of the land, and the aspect of the same. Until we are in possession of the results of such experiments as are here indicated, together with any others that it might be thought proper to make, carefully conducted in every part of the country, we will not be able to make up our minds as to the exact extent of plantations which should be planted on a particular part of the country, with a view to its being put into the best possible state for the health of men, and for the rearing of profitable crops to the very best advantage. This, then, is a branch of arboriculture to which every one engaged and interested in it should devote his best attention, as it is only by united and well applied efforts that any successful conclusions can be arrived at. At present the subject is comparatively little understood by the great majority of those who are most interested in the matter, and therefore it will be to the credit of future arboriculturists if they can furnish the public with such reliable facts as will enable them to draw definite conclusions.

2533. It must always be kept in view, however, in carrying out experiments on the subject under notice, that even were correct conclusions arrived at in respect to the amount of planting required for any particular country, such conclusions must always be affected, and even perhaps in time rendered in some degree unsound, by the altered condition of a neighbouring country, or even by that of a part of the same country. There can be no doubt of this, and it is but reasonable to infer that the great clearings that have been and are still being made on the North American continent, and on the continent of Europe, have tended very much to alter the climate of the British Isles; for who does not observe the altered state of our climate within the memory of the present generation? We do not mean to state that its altered climate is attributable to that cause alone, for even our own lands have undergone great changes within our own remembrance; and this too has to be taken into account. Still, when we consider that such an enormous acreage of woodlands are being cleared every year in North America, and a large portion on the continent of Europe as well, it is not to be doubted that such clearings affect the British climate, although we cannot say to what precise degree. Without a judicious distribution of trees, no country can be profitably occupied by man, nor cultivated by the farmer; therefore arboriculture may be truly said to be the pioneer of the improvement of the surface of the globe. Look, for example, at the state of farming on the prairies of North America. There many farmers have been obliged to abandon their subjects, from the excessive dryness of the climate, and in consequence of the storms of wind destroying their crops and everything they possessed. We have this information from the parties themselves,—and all this from the want of trees to protect their crops from storm, and to maintain a due balance of moisture in the air. This state of things on those treeless wastes is now, however, exciting the attention of the settlers on them, and they are planting trees as they proceed in their march of improvement,—carrying out plantations before them to a very large extent. It is arboriculture, then, that is to render those vast American plains habitable for men, and profitable to the country. Our brethren in America are now alive to the vast advantages of woods for the successful improvement of their boundless plains, naturally rich in the character of their soil; and, therefore, in the hands of such an energetic people as they are, those territories which are now, from want of trees, uninhabitable for man, will ere long become teeming with human industry, and overflowing with wealth—all from a judicious application of arboriculture.

2534. Arboriculture is destined to be equally powerful for the improvement of the treeless regions of South America, for the deserts of Africa, and for that of the vast wastes of Asia and Australia. Can any one doubt that, under a well-directed system of planting trees on any and all of those regions, they could not be made highly profitable for occupation by man? Might not the reoccurence of such terrible famines as have hitherto been too common in some parts of our Indian Empire be, to some extent at least, checked by a wise and judicious system of planting, and a proper distribution of the forests of that country. We are of opinion that arboriculture is to be the means of reclaiming all those regions, and rendering them fit abodes for man, and all his dependants and industries: it is to be the means of procuring sustenance to many hundreds of millions of people, after the present habitable parts of the earth shall have become overstocked. Yes, on these vast tracks which are now considered the useless parts of the globe, there will yet be spread out, by means of a proper application of arboriculture, ample fields for vast populations exercising every human industry—many species of industry of which we of the present age can have little or no idea.

2535. Arboriculture is to change the natural aspect of every country in which it may be properly applied, and its details carried out. Let us take the case of our own country as an example in point. We now cultivate trees brought from all the temperate regions of the globe, and the result of this must be in time, that our woods and parks will exhibit features of scenery quite foreign to our land, and characteristic to some extent of the various regions from which the trees were introduced. Another generation will see the dark forms of the *Picea nobilis* and the *Abies Douglasii* towering in majestic grandeur above the common trees of our woods and plantations, presenting outlines of a truly American character in the landscape; while the *Sequoia gigantea* will in time stand out above all, as beacons pointing out the seats of the wealthier classes of the land,—these forming grand contrasts to the many other foreign species spread around and under them. Who can consider all these points, and not come to the conclusion that arboriculture is of vast importance both to the welfare and pleasure of all the nations on the globe, and that no people can be said to be great, refined, and powerful, which does not attend to it? The future of arboriculture is not confined to any one people or nation; it is to be a universal science, adapted to promote the comfort and happiness of every people in every clime, and to secure rich harvests to the industry of all that will put it properly into operation.

2536. The future prospects of arboriculture in this country are far more promising now than they were forty years ago. Then practical forestry was but little understood, even by those who paid most attention to it; but now landed proprietors, scientific men, and practical foresters are beginning to see, that unless in the future a well applied and judicious system of arboriculture is adopted in this country, we will certainly feel the effects of our neglect when we least expect them. The only way we can in the future depend upon securing the benefits which are to be derived from a system of arboriculture based upon natural laws, and carried out with well directed judgment, is by the thorough education of our foresters. Upon them chiefly will depend the carrying out of all the operations in connection with the planting, distribution, and general management of the forests of the future—not only in this country, but in our colonies as well. Care should be taken, therefore, that in the future we have such a class of foresters as have received a sound general education in all the theory of their profession, and have put the same into real practice, with the object of testing the soundness of the teaching they receive. We do not mean to infer that the foresters of the future should be men of theory alone, but we maintain that they must be practical men, who are thoroughly acquainted with the theory of all the branches of arboriculture.

2537. Unless in the future we have a better system of educating our foresters in this country than we have at present, the advancement of arboriculture will be slow, from the want of a sure foundation. It is therefore the duty of the Government to establish such a national means of education for foresters as will be for the future benefit not only of this country alone, but of all her colonies and dependencies. Such a means can only be supplied in the form of a thoroughly equipped school of forestry, established upon a really practical basis, and supplied with the means of affording all the theoretical knowledge that will be required. Upon such an establishment will greatly depend the success of foresters in the future, in bringing about those improvements which arboriculture demands at the present time.

2538. Among foresters themselves, at the same time, a properly united action is required. We have this, to some extent, in the Scottish Arboricultural Society, which has as its object the advancement of arboriculture in all its branches. But hitherto the action of this society, however useful in some respects, has not, in our opinion, been such as might have been expected from a body of men with such an important object in view. We trust, however, that ere long this society will take a leading part in bringing about the establishment of a school of forestry in Scotland, and in having meteorological stations appointed in all parts of the country where its members reside.

2539. Within the last five years the claims of arboriculture have been advanced very considerably, and brought before the public as a subject worthy of our best attention, by the establishment of the 'Journal of Forestry and Estates Management.' This periodical is published with the exclusive object of furthering the aims of forest science, and we are glad to know that, so far as it has gone, it has been the means of drawing attention to the subject. We wish every success to such a periodical, as it is well calculated to bring about an improved state of things in regard to forestry, both in this country and in the colonies.

APPENDIX.

MEMORANDUM by D. BRANDIS, INSPECTOR-GENERAL OF FORESTS, ON THE PRESENT CONDITION OF FORESTS IN INDIA; in reply to questions sent to him by Dr JAMES BROWN of Benmore House, Port Elgin, Ontario, for the fifth edition of 'The Forester,'—dated Dehra Dun, the 18th August 1881.

1. *What is about the extent of forests in British India?*

It is not possible to give a complete reply to this question. What is ordinarily known as India comprises a total area of 1,490,335 square miles, or more than 12 times the extent of Great Britain and Ireland (120,000 square miles). But this comprises a large area in Natives States, where the authority of the Government of India is limited to the control of the foreign relations of those States with other countries. The extent of country actually under British administration in India, excluding Mysore, which is now under native rule, is 869,149 square miles. Of this area, about 246,386 square miles, or 28 per cent, is under the plough; and of the balance—viz., 622,763 square miles, a large portion is waste land and pasture land, much of which is covered with trees or brushwood. No sharp division between forest, waste, and pasture land is possible.

By way of illustration, I may mention two provinces, Assam and Burma. The total area of Assam is 45,302 square miles. Of this area, a small portion only (6750 square miles) is under cultivation. About 8000 square miles are Government forest, but there is besides a very large extent of private forest. Thus, in the Goalpara district, there are about 520 square miles of forest, the property of zemindars (large native landholders), while in the chief tea-producing districts of Cachar, Sibsagar, and Lakhimpur there are about 550 square miles of forest land in the hands of (principally) European tea-planters. For the other districts no definite data regarding the area of the private forests are available; and there are, in addition to the forest, vast areas of grass land and waste, both private and the property of Government. Of the forest in Assam at the disposal of Government, the area actually demarcated and set apart as reserved forest, to be permanently maintained as such, is only 2015 square miles. As far as plans have been formed, it is intended to increase the area of reserved forest to 3000 square miles.

The total area of the province of British Burma is 87,220 square miles, and of this area only 5334 square miles are cultivated, the rest being forest and grass land, nearly the whole of which is at the disposal of Government. According to present proposals, about 3500 square miles will be demarcated and set apart as reserved forest, and of this the demarcation of 1600 square miles has already been completed.

Assam and British Burma are instances of provinces in which the greater part of the area is as yet covered with forest. In other provinces the forest area is much less, but there is great variety in the conditions of the different provinces.

2. *What are the chief kinds of trees found in these forests? Please give the botanical names.*

The variety of trees in India is much greater than in Europe. In Great Britain the species of indigenous trees number only about 40, while in India they number about 2000. As a rule, those species are most important which are found in large quantities, and the timber of which is most durable in the climate of India; and of these it must suffice to name the following:—

(*a*) The Deodar (*Cedrus deodara*)—found on the mountains of the North-West Himalaya, between 6000 and 9500 feet elevation, in forests which are rarely pure, but in which the deodar is mixed with other pines and several species of oaks.

(*b*) The Sissu (*Dalbergia sissoo*) — a gregarious tree, which is commonly found along the rivers which issue from the Himalaya, fringing their banks and extending far up into the hills to an elevation of 3000 feet, and forming large forests along the rivers outside the hills. It is one of the best woods in India, of a rich brown colour, strong, durable, useful for furniture, carriage-building, and other purposes.

(*c*) The Khair (*Acacia catechu*) — a gregarious and most useful tree, of very wide distribution, common in North India, often associated with sissu in the valleys of the rivers which issue from the Himalaya, and also found in the drier districts of British Burma, both on low ground and on the hills. The red heart-wood is extremely durable, and is used for house-posts and building generally. The heart-wood is also used on a very large scale for the manufacture of cutch or catechu, a most valuable tanning material, which is an extract made by simmering chips of the wood in water, and by boiling down the dark-coloured fluid into a hard, shining, black mass, the catechu of commerce.

(*d*) The Sál (*Shorea robusta*)—a most remarkably gregarious tree, in leaf nearly throughout the year, with great powers of reproduction. The heart-wood is hard, heavy, and durable; it is used extensively for building and for railway sleepers throughout Northern and a great part of Central India. The sál forms extensive forests, almost pure, both at the foot of the Himalaya and on the hills of Central India, stretching from the banks of the Ganges in Lower Bengal to the sandstone hills of Pachmarhi in the Central Provinces.

(*e*) The Teak (*Tectona grandis*)—a deciduous tree, with large rough leaves, attaining a great size. This, the most important of the Indian timber trees, is found in mixed forests, associated with bamboos and a great variety of other trees, over the whole of South India and in Burma, extending in Central India and in the interior of the Trans-Gangetic Peninsula to north latitude 26°. The timber of teak is prized in India more than that of any other trees, and it forms an important article of export to Europe and America from the Burma ports.

(*f*) The Blackwood (*Dalbergia latifolia*)—an evergreen tree, with handsome dark-coloured heart-wood, which is much prized for furniture, is found in mixed forests all along the Western Ghâts, where it attains a large size. The tree is also found in other parts of India, but does not here attain any large size. The blackwood or rosewood belongs to the same genus as the sissu of North India, but its wood is darker-coloured and more heavy.

(*g*) The Babul or Kikar (*Acacia arabica*)—a gregarious tree, with a hard and heavy heart-wood, which forms extensive forests along the Indus in Sind, where the life of the tree is maintained in an arid, almost rainless, climate by the annual overflow of the river. It also forms extensive forests along the rivers and on stretches of low land in the dry region of the Deccan, and is extensively cultivated in many districts of India, extending north to the foot of the Himalaya in the Punjab.

(*h*) The Toon (*Cedrela toona*)—a fast-growing tree, with bushy foliage and light, red-coloured wood, somewhat resembling mahogany, nowhere gregarious, but found scattered on rich moist soil in the outer valleys of the North-West Himalaya and in Burma.

(*i*) The India-Rubber (*Ficus elastica*)—a huge evergreen tree of the fig tribe, with thick leathery shining leaves, which sends numerous aerial roots down to the ground from its branches. The rubber or caoutchouc is a white milk which exudes from cuts made in the stem and roots. The tree is indigenous in the moist forests of Assam and Eastern Bengal, but does not extend south further than the 24th degree of north latitude.

(*k*) The Sandal (*Santalum album*)—a small evergreen tree, with elegant hanging branches and small black berries, valuable on account of the exceedingly fragrant heart-wood, which is used for carving and incense, and is largely exported to China. The tree grows in the drier regions of South India, generally in open forests or on waste lands, and commonly in hedgerows and on fields. Its chief habitat is the state of Mysore and the adjoining districts of the Madras Presidency, where it is held to be a royal tree, which may only be cut by permission of Government.

3. *What proportion of these forests is kept under the special management of the Government?*

In the provinces under the Government of India, not including Mysore, which is now under its own Native Government, the area of reserved forests, which have been demarcated and set apart to be permanently maintained as forest, aggregated 14,890 square miles on the 1st April 1880. Outside these reserved forests a certain control is exercised over a portion of the remaining forest area in these provinces; but the forest domains of the State, which it is intended permanently to maintain as forest, have the area which is stated above.

In the Bombay Presidency the area of reserved forests aggregated on the same date 9670 square miles. But here, as in the provinces under the Government of India, the work of demarcation has not been completed, and is still in full progress.

In the Madras Presidency the process of setting apart and demarcating the Government forests intended to be permanently maintained has made less progress than in any of the other provinces. There are upwards of 16,000 acres (25 square miles) of forest plantations, and about 279 square miles of reserves, under the control of Government, selected and demarcated in the vicinity of the lines of railway, chiefly for the purpose of furnishing a permanent supply of locomotive fuel.

4. *Has planting been undertaken to any considerable extent in the reserved parts of these forests?*
5. *Has drainage been applied to wet parts of the land previous to planting?*
6. *What are the principal kinds of trees planted?*
7. *At what distances apart are the young trees planted?*
16. *Is planting much attended to by private landholders in India?*
17. *Have any nurseries been established in India for the rearing of forest trees?*
18. *Are any of the seeds of any of the trees sown on their permanent sites?—Or are the young trees transplanted from the nurseries?*

In the provinces under the Government of India, the area under regular plantations aggregated 32,461 acres; but in addition to this, sowing and planting and other cultural operations are undertaken annually on large extents of forest, chiefly with the object of promoting the growth of the more valuable species. In the Madras Presidency, as already mentioned, the area planted aggregates 16,000 acres, and this includes the well-known teak plantations of Nilambur in the Malabar District, which cover an area of 3500 acres, the oldest portions of which were planted in 1842, and are therefore now nearly forty years old.

In the Bombay Presidency there are no very extensive plantations, but much has been done to facilitate the regeneration of forest, particularly on the dry hills of the Deccan, by strict protection and broadcast sowing. Similar measures have been taken with great success over large areas, aggregating 68,000 acres, in the babul forests of Sind, near the banks of the Indus.

The principal kinds of trees planted are chiefly those which have already been enumerated as those which are the most important.

In the hills of the North-West Himalaya the deodar is the chief tree planted. In the plains of the Punjab, where wood is scarce, extensive plantations have been made of sissu. Thus, in the vicinity of Lahore, on the low moist land near the Ravi river, and at Changa Manga on high ground, with the aid of irrigation, extensive sissu forests, aggregating 14,000 acres, have been raised artificially within the last twelve years, the older trees in which are now nearly 30 feet high. The wood produced in these plantations is sold as firewood, partly for locomotive fuel, partly for consumption at Lahore.

Teak is planted on a large scale in Burma, and here a plan has been followed with great success which is known under the name of toungya teak plantations. The Karens and other tribes which inhabit the hills of Burma practise a shifting kind of cultivation, by cutting and burning the forest, and raising one or two crops in the ashes. On the clearances thus made, and together with the rice, which is the chief crop raised by these people, the teak seed is sown, and the result is a complete crop of that valuable tree, provided the bamboos, the coppice-shoots of other trees, grass, and herbs are cleared sufficiently. For this is the great difficulty in all sowing and planting operations in the moister and tropical parts of India, that the growth of bamboos and other trees is so luxuriant that the teak or other kinds planted get choked. On the system of these toungya plantations, a total area of 2515 acres had been planted up to the 1st April 1880, at a cost, on an average, of Rs. 9-14, or about 16 shillings an acre; and the plantations on this system are now being extended annually on a large scale in the forests of British Burma.

The excellent Nilambur teak plantations have already been mentioned. There are teak plantations on a smaller scale in North Kanara, on the banks of the Kalinadi, and in many other places within the range of that tree. And as an experiment, the tree has been planted outside the limits of its natural distribution, in Assam and in the Chittagong district of Bengal.

Sál reproduces so freely, naturally, that plantations of this tree are not as a rule required. By way of experiment, plantations have, however, been established, in order to stock open grassy plains; and the best method has been found to put out plants from the forest. A peculiarity of the seed of the sál tree is, that it germinates immediately after ripening, and that it loses its power of germination very quickly. Hence it is neither possible to keep the seed for any length of time nor to send it to any distance.

Extensive plantations of india-rubber have been made in Assam. In its natural state this tree generally germinates on the branches of old trees. At first these seedlings make very slow progress, but they commence to grow more rapidly as soon as some of the aerial roots thrown out by the young plant have reached the ground. The young india-rubber plant requires a great deal of light, which it finds more on the branches of trees than on the ground under the shade of the forest. Self-sown seedlings on the ground are only found in open places where there is an abundance of light. Experiments were made to imitate the natural reproduction of the tree, and to sow the seed in the forks and branches of trees; but this process was found to be so extremely slow that it was abandoned, and broad lines were cleared, instead, through the forest, and the seedlings were planted out on raised mounds of earth. This plan has succeeded admirably, and several hundred acres have now been planted on this system. The lines are 100 feet apart, and the distance between the plants within the lines is 25 feet. These great distances are necessary, as the india-rubber fig is an exceedingly spreading tree, which, at the distances named, may be expected to take up the greater part of the ground.

As regards the establishment of nurseries, it may be said that the general rule is to sow the seed as much as possible in their permanent sites, but that nurseries are always established simultaneously with these sowings, with the view of filling up blanks by planting out from the nurseries. In the case of some trees, such as india-rubber, no sowing in the permanent sites is possible.

As regards the distances at which the young trees are planted out, this necessarily varies according to the kind of trees planted, and the circumstances of the case. But it will be well to mention here that in many cases the plan of sowing or planting in lines has been found to answer best. The lines are, according to circumstances, 10, 20, or 30 feet apart, and the distance between plants or seed plots within the lines is much less. The main object of this system is to facilitate control and to diminish expense. The system of planting and sowing in lines is particularly useful where the growth of grass, weeds, coppice-shoots, and bamboos is so heavy that the plants require clearing during a series of years to prevent their being choked. Under such conditions it is more economical to clear the jungle only along certain well-defined lines, and at the same time, as the plants grow up close together within the lines, they are soon enabled to cover the ground and to draw each other up; while the elbow-room given them on either side enables the naturally stronger or more favoured plants to get the upper hand over their weaker neighbours. Thus the process of natural selection is promoted, the expense of clearing is diminished, and control is facilitated. The plan has a further advantage in India, where in most cases the thinnings of plantations are unsaleable, that, the lines being far apart, it takes a long time before the trees close overhead laterally, and before thinnings become necessary.

There has been no occasion for any extensive works of drainage for forest planting in India. In regard to this point it must be explained that the climate of India differs widely from the climate of Scotland. In almost all parts of the country the year divides itself into two well-marked seasons, the dry season and the wet season. There are, indeed, large tracts of country in which the climate is so dry that there is either no wet season at all or very little rain during the wet season. In these, the dry and arid regions of India, no drainage for planting is wanted, save in exceptional cases. In the greater part of India, however, the whole of the rainfall takes place during one season of the year, which generally commences in spring and lasts until autumn, being longer in the moist regions and shorter in those which are dry and arid.

The result is, that during the wet season the ground is soaked with water, except on the hillsides and on soils which transmit water freely. Certain classes of trees can live under these circumstances in soil which is wet and soaked with water. Indeed, there are extensive forests in which the water stands on the ground during a great portion of the rainy season. For such trees, if it were proposed to make plantations of them, drainage is not required. But there are other classes of trees which absolutely require a well-drained soil, and which cannot live under other conditions. The teak tree belongs to this class: it is only found on the slopes of hills, or elsewhere where the water during the monsoons drains off rapidly. Consequently, the planting of teak is only attempted on suitable ground which is naturally well-drained. Sál also is a tree which only thrives on soil well-drained, but, as already explained, plantations of this species are not as a rule required.

The result is, that for forest plantations in India drainage is only required in exceptional cases.

No extensive forest plantations have as yet been made by private proprietors in India, although the protection and management of natural forests is not altogether unknown.

8. *In planting trees, have any of the common trees of Europe been introduced? Please name the kinds.*
9. *Have any of the deciduous trees of America been introduced? Please name the kinds.*
10. *Have any of the American coniferæ been introduced? Please name the kinds.*
11. *Have any of the trees of Australia been introduced? Please name the kinds.*
12. *Are the soil and climate of India well suited to the healthy growth of foreign kinds of trees?*
13. *Have trees been introduced from any other foreign parts? Please name the foreign parts and the kinds of trees.*

None of the trees of Northern Europe or North America have been introduced on a large scale in India, the climate of most parts of India being totally different. Some trees of South Europe, such as the sweet chestnut, the Spanish olive, and the Carob (*Ceratonia siliqua*), have been introduced in Northern India; and of these, the sweet chestnut has succeeded remarkably well in certain situations in the North-West Himalaya. From South America the *Pithecolobium saman* has lately been introduced, with great success, in the tropical provinces of India, and particularly in the moister districts, its extreme rapidity of growth being its chief recommendation. The mahogany has been brought from the West Indies, and is cultivated in the Bengal and Burma forests, where it thrives well. The mahogany grown near Calcutta yields timber equal to that of the American tree. Several of the South American caoutchouc trees are also cultivated by way of experiment in Malabar and the southern districts of Burma, where the climate is favourable. The different species of cinchona should also here be mentioned, extensive plantations of which have been made on the Nilgiris and in Sikkim within the last twenty years.

Of fruit trees, a large number have come from America, such as the guava and custard apple; but these are old introductions.

From Africa no forest trees have been imported recently, but the Baobab (*Adansonia digitata*) is an old introduction, and large specimens of this remarkable tree are found here and there, near villages and Mohammedan shrines. The Tamarind tree (*Tamarindus indica*), which is commonly cultivated on account of its fruit, is also probably an old introduction from Africa.

As regards forest trees, the most important introductions have been made from Australia. Forests, raised by planting within the last thirty years, of the *Eucalyptus globulus* or blue gum cover large areas on the Nilgiris, and several species of *Acacia* also have been extensively planted. Other species of *Eucalyptus* have been found to thrive in the plains of North India and in some places of the North-West Himalaya.

14. *What is the general condition of forests and plantations as now existing in India?*
15. *What is the system of forestry at present understood and practised in India?*
19. *Remarks.*

The chief object of forestry in India is to secure a permanent supply of timber and other produce for local consumption and for export trade. Some of the more important articles produced in these forests, besides timber, firewood, and bamboos, are the following: *Caoutchouc*, the produce of *Ficus elastica*, which has already been mentioned; *Shell-lac* and *Lac-dye*, made by the lac-insect, which lives on a great variety of trees, and which is propagated artificially on a large scale in certain districts of the Central Provinces; *Sandalwood*, already mentioned; *Cutch*, the extract made from the heart-wood of *Acacia catechu;* and *Myrobalans*, the dried fruit of several species of *Terminalia*, particularly of *Terminalia chebula*, a most valuable article for tanning, large quantities of which have of late years been exported to Europe and America.

Of timber, the kinds previously named are the most important; but besides those named, there are other kinds which are valuable, either because they are durable or for other reasons.

A peculiar feature in most Indian forests is that they do not, like the Scotch fir forests of the Highlands, the beech forests of Buckinghamshire, and like most forests of Europe, consist of one or a few kinds of trees only, but that they are mixed, consisting of a great variety of trees, of which generally the majority are worthless, a few kinds only being valuable.

Thus teak is associated with a large number of other trees in the forests of Burma or South India, and most of its companions have no (or very little) value, and cannot be utilised. This peculiar feature of the mixed forests of India renders their systematic management and working extremely difficult, and every effort is made to increase the proportion of the more valuable kinds, and to devise means for utilising those which are of less value.

Bamboos are commonly found in many Indian forests: but while in some forests they are valuable, and can readily be disposed of, they are without any value in others; and in such places they are a disadvantage, as they impede the development of the more valuable trees.

The demand for firewood and charcoal is limited in most parts of India. Dried cow-dung is used for fuel on a very large scale, and it would be a most important and advantageous measure to increase the use of firewood, and thus to stimulate the use of manure for its legitimate purpose. But even if the whole of the people took to using firewood for cooking, sugar-boiling, and other purposes for which cow-dung is used at present in many parts of India, the demand for firewood would not be sufficient to utilise the entire mass of the less valuable woods which are the companions of teak and other valuable kinds of trees in the Indian forests.

Hence it has become necessary to devise other means for utilising the great mass of the less valuable woods. For this purpose it has been proposed to revive and extend the old native charcoal-iron industry, and to impregnate such woods with antiseptic substances, so as to make them more durable, and hence more readily saleable. At present the difficulty remains in many forests of India that there is no demand whatever for any except a few valuable kinds of timber; and that as these are cut out, the less valuable kinds take their place, unless much outlay is incurred in sowing and planting.

These are some of the peculiar conditions under which forestry is practised in India. Now as to the outlines of the system followed, and the present condition of the forests. The first step has been to select from the waste and forest lands which were at the disposal of Government certain areas most suitable to be permanently maintained as forest, to place them under efficient protection, and to improve them steadily, so as to increase the proportion of the more valuable kinds of trees.

The first and most important step which requires to be taken in improving these forests is to exclude fires, which throughout the greater part of India were formerly a regularly and annually recurring event during the dry season. The chief cause of these annual forest fires is the universal practice of setting fire to the dry grass and leaves in the hot season, the object being to produce a crop of fresh green grass for the cattle, to facilitate shooting and hunting, or to afford protection against wild animals. In many cases these fires are caused by the burning of forest cut down for toungya cultivation, or by mere carelessness.

It has already been stated that the total area of demarcated forests in British India, excluding Madras and Bombay, amounted to 14,890 square miles on the 1st April 1880. Of this area, 795 square miles are in the Punjab, where, though fires do occur and are often very destructive, they are not a regular annual institution, and where, as a rule, no special measures are taken to guard against them. Of the forests in the remaining provinces (14,095 square miles), an aggregate area of 3700 square miles was protected during the hot season of 1880, and a large portion of this area had been protected for several years previously. This result has not been accomplished without great labour and considerable expense, in clearing and burning lines round the portions protected, and in entertaining special guards and watchers. During 1879-80 the outlay on this work amounted to Rs. 70,000. Nor has the progress made in this work been uniform in all provinces. Thus, while in the Central Provinces nearly one-half of the permanent forest area is under protection from fire, a small proportion only of the total area is protected in Burma.

Eventually it is intended to bring the greater portion of the permanent forest area under fire protection; and this is necessary, for these fires injure the standing trees of all ages, destroy seed and seedlings, and cause the soil to deteriorate.

Systematic efforts to exclude fires from the forests have been confined to the provinces under the Government of India, although in some districts of the Bombay Presidency, particularly in North Kanara, considerable success has been attained in this respect.

Next in importance to fire protection are plantations, which have been mentioned already; but it is obvious that no planting operations can be of any value unless the ground on which they are made is protected from fire. It will now be understood that the production of young growth, to replace the trees cut down, is secured partly naturally by self-sown seedlings, for which purpose protection from fire is essential, partly artificially by planting, with the special object of increasing the proportion of the more valuable kinds in the forest.

The management of the extensive Government forest estates requires the construction of roads, bridges, rest-houses, the clearing of streams for the purpose of floating timber, and other works. For these objects the outlay during 1879-80 has amounted to Rs. 166,000.

The surplus revenue yielded to the State by the management of these forests is not as yet very large. The reason of this is that cuttings are restricted to the utmost, and that attention is chiefly devoted to the formation and improvement of these forest estates. Yet the revenue yielded by these estates is increasing steadily, though the charges for protection and improvement have necessarily risen in a larger proportion. The following figures will explain the progress which has been made in this respect during the last sixteen years. They show average annual receipts and charges during the following periods:—

	From 1864-65 to 1868-69.	From 1869-70 to 1873-74.	From 1874-75 to 1878-79.	In 1879-80.
	Rs.	Rs.	Rs.	Rs.
Receipts,	3,920,700	5,853,000	6,881,000	7,336,000
Charges,	2,263,000	3,964,000	4,518,000	4,739,000
Surplus,	1,657,700	1,889,000	2,363,000	2,597,000

These figures include Mysore, which province was under British administration during the period in question.

A word should now be said regarding the establishments employed for the protection and management of these forests. The chief forest officer in each province or subdivision of a province is styled "Conservator of Forests." The circle under his control is subdivided into a number of divisions, each division forming the charge of a superior officer, generally a Deputy or Assistant Conservator. Divisions are subdivided into ranges or executive forest charges. Ranges are the most important unit in the whole organisation. Their extent varies exceedingly, but it is probable that eventually an average area of about 30 square miles, or 20,000 acres, will be found to be the most convenient size for these executive charges. In the provinces under the Government of India it has already been stated that the area demarcated to be permanently maintained as forest amounts to about 15,000 square miles, and it is probable that this area will be increased to 20,000 square miles. Under these circumstances it may be assumed that eventually there will be about 660 executive charges or forest ranges in these provinces. It is intended that when the organisation has been completely worked out, ranges shall be held either by rangers or by junior officers of the superior staff. All rangers are and will be natives, so that the filling of these appointments will require the training of an efficient body of at least 600 native officers, all well educated and competent to hold executive charge of a forest range. For the purpose of training this body of men, a forest-school has lately been established at Dehra Dun in the North-Western Provinces; and the arrangement is that eight months in the year are devoted to practical training, while the remaining four months, during the slack season in summer, are devoted to theoretical instruction in mathematics, the natural sciences, and forestry.

At present the number of rangers is only 97, and hence ranges are frequently in charge of subordinate officers. On the successful training of the needful number of rangers will mainly depend the success of forest administration in India, and the strength of the Forest Department will chiefly lie in the formation of an efficient body of executive officers or forest rangers.

It is here the place to say a few words regarding the arrangements made for the professional education of the officers who are destined for the superior staff of Conservators, Deputy and Assistant Conservators,—in fact, of the officers in charge of circles and divisions.

As the organisation of forest administration is perfected, all these officers, excepting some of the junior men, who must commence their practical career as executive officers in charge of forest ranges, will be controlling, inspecting, and directing officers. The number of these appointments will therefore be limited. It is at present 93, and is not likely to be increased beyond 100 for the provinces under the Government of India. Obviously, these are most important and responsible posts; the men must be gentlemen, and they must have such a good general education as will fit them for high administrative duties. Under existing arrangements, this superior staff of officers is recruited by the appointment annually of a few young Englishmen, who are selected by the Secretary of State for India, on the ground of an examination in mathematics, natural sciences, and other branches of knowledge, and after going through a course of professional training in the State forests of the continent of Europe, chiefly in those of France. Here they learn the methods adopted for administering large Government forest domains; they become familiar with the organisation of a large public forest service; and, among other professional matters of importance, they learn to appreciate the success attained by the system of natural reproduction.

From the commencement great care has been taken to maintain an intimate connection between forest administration in India and in those countries of Europe where large areas of State and Communal forests are managed according to a regular system. In building up the system of forest administration in India, we have thus utilised the experience gained in those countries by the work of centuries, instead of following the ideas and theories of individual men. The formation of the Government forest domains in India and the organisation of their management has been a large undertaking; and whatever success has been attained in this matter is due entirely to our having utilised the experience gained in forest administration in Europe.

As far as matters have gone, the chief work in forest conservancy in India has been done by the British Government. Attempts have, however, been made by the Governments of several Native States to protect their forests efficiently, and to manage them on a regular system. Thus, a regular Forest Department has been established in the Nizam's dominions, in the States of Patiála and Sirmúr in the Punjab, and in other Native States. Some of the chiefs of the Hill States near Simla have entirely and successfully prohibited the annual firing, during the dry season, of the grass and forest lands in their territories, and others have established extensive forest preserves.

In many of the drier districts of India, such as the States of Rajputana, there are old established forest and grass preserves, in some cases the property of the State, in others the property of large landholders, which are maintained and carefully protected, partly to afford cover for game, partly to furnish fuel and building wood, and partly, during seasons of drought, to secure a supply of grass and leaves for cattle-fodder. In many districts, also, sacred groves exist, which are most carefully protected. Not much, however, has been done by native proprietors beyond protecting the areas set apart for forest growth; and attempts at establishing a regular system of forest management have as yet only been made by the British Government.

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JAMES BROWN (Author of 'The Forester') takes this opportunity to inform the Commissioners of Woods and Forests, and the other Administrative Departments of the British Empire, and of the United States of North America, that he is prepared to inspect and report upon National Forests. He undertakes to draw up schemes for their being properly conserved, systematically extended, profitably managed, and in all respects dealt with in a way adapted to the climate and other conditions of the country in which the forests are situated.

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